General Psychology

TEXTBOOKS ON PSYCHOLOGY

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PUBLISHED BY

D. VAN NOSTRAND COMPANY, INC.

General Psychology

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Second Edition—Fifth Printing

D. VAN NOSTRAND COMPANY, INC.
Princeton, New Jersey
New York • Toronto • London

D. VAN NOSTRAND COMPANY, INC.
120 Alexander Street, Princeton, New Jersey (*Principal Office*)
24 West 40 Street, New York 18, New York

D. VAN NOSTRAND COMPANY, LTD.
358, Kensington High Street, London, W. 14, England

D. VAN NOSTRAND COMPANY (Canada), LTD.
25 Hollinger Road, Toronto 16, Canada

Published simultaneously in Canada by
D. Van Nostrand Company (Canada), Ltd.

First Published, June 1952
Reprinted, December 1954,
July 1956, January 1960,
July 1961

Designed by Lewis F. White

Library of Congress Catalog Card No. 52-6382

Printed in the United States of America
By Lancaster Press, Inc., Lancaster, Penna.

to Ruth
and Joan

Preface

In writing "General Psychology" the author has had in mind the typical introductory course in psychology in colleges of liberal arts. An attempt has been made to give a balanced and unbiased picture of scientific psychology as it is today. No particular school or point of view is followed, yet the significant and enduring contributions of them all are included.

In this second edition a major shift in emphasis has been to make the presentation more student-centered and less subject-centered. For example, the first chapter, instead of elaborating upon an abstract definition of psychology, gives the student a quick survey of the work of the psychologist, both academic and professional, and points out psychological problems of daily life. Suggestions for application of psychological findings to the student's own life have been increased; for instance, there are sections on how to concentrate and on how to manage emotional behavior. Many new illustrations have been selected with a view to their human-interest value. In spite of this new emphasis, the view of psychology as a science and its place in our culture have not been lost.

A major change in the order of chapters has been to introduce those on motivation, feeling, and emotion immediately after the third chapter, which is on development, and to follow them with the chapters on sensation and perception. The latter still precede the chapters on learning and thinking.

The volume is somewhat shorter, as indicated in part by the fact that there are 22 chapters instead of the original 26. Some of this condensation was effected by elimination of parts of the material on the nervous system, on sensation, attention, and perception, and on individual differences. Some of it was brought about by consolidations. For example, the two chapters on human abilities have become one, also the two chapters on personality. A new chapter on development has been introduced very early in the volume. This includes the material retained on the nervous system and on problems of heredity as well as the new material on growth and maturation.

I am indebted to various sources for photographs used in new illustrations, among whom are: Albert F. Ax, Lester F. Beck, Guy T. Buswell, Arnold Gesell, E. R. Guthrie, G. P. Horton, Norman R. F. Maier, Harold C. Trueblood, *Look Magazine,* The Psychological Corporation, and Western Air Lines. I am grateful to Fred Meise for his care and ingenuity in the preparation of a number of new line drawings. The color illustrations in Fig. 9.2 are reproduced, with permission, from the *Kodak Handbook,* published by the Eastman Kodak Company. The color illustration in Fig. 9.8 was generously provided by Israel Dvorine from his *Color Discrimination Screening Test.* To my wife, Ruth B. Guilford, I am indebted, as usual, for reading and otherwise assisting in preparation of the manuscript.

J. P. Guilford

Beverly Hills, California
May, 1952

Contents

CHAPTER I

What Psychologists Do

If you had begun your study of psychology some thirty or forty years ago, you would have found it defined as the science of the mind or as the science of consciousness. Since that time it has often been defined as the science of behavior and occasionally as the science of human nature. Some say that it is the science of consciousness *and* behavior, and others say that it has to do with the adjustment of an organism to its environment. In this volume psychology is defined as the science of mental activity of organisms, with the idea that "mental activity" is virtually the same as behavior or as adjustment to the environment.

A more concrete way of understanding what psychology is all about is to get a glimpse at what psychologists actually do. We will therefore take a look at different kinds of psychologists and some of the things that they do. It will help some to keep in mind that there are roughly two major kinds of psychologists. There are those who devote their efforts to discovering the basic facts and principles of mental activity (they are sometimes called "pure" psychologists), and there are others who put facts and principles to work in attempting to help humanity in one way or another (sometimes called the "applied" psychologists). Actually, there is no clear-cut distinction between the two groups. Many a psychologist combines both kinds of interests and both

kinds of activities in what he does. A more useful distinction for our purposes here is that between academic psychologists (those who teach and do research at colleges and universities) and professional psychologists (those who are employed by other agencies or are self-employed). We will look at these two groups in turn.

Psychologists Who Teach

A great part of the advancement made in the sciences comes from investigators who teach in our institutions of higher learning. This is also true of psychology. What do we find psychologists doing in the laboratories of this country and of others? The answer to this question is best told by mentioning some of the things that psychologists in the major special fields are now investigating.

Experimental Psychology. There is a group of investigators known as experimental psychologists. This is not because they are the only ones who use experimental methods.* They are interested in the basic problems, some of which the new science of experimental psychology chose to investigate when modern psychology got its start about a hundred years ago. Before that time there had been almost no experimental studies of psychological problems.

Some experimental psychologists are continuing today to find out how our senses operate; how we see, hear, taste, smell, and feel. They want to know how, with the use of our senses, we come to know the world about us. Others want to know how it is we learn, whether it is a matter of acquiring new information or some skill such as figure skating or piloting an airplane. How do we retain what we learn, how do we remember, and what makes us forget? How do we think, imagine, and plan? How are we able to speak and to write? What makes us want to do some things and to dislike to do others? Why are some interested in certain things while others are not? What makes us feel emotions and why do we sometimes lose control of ourselves?

*Experimental methods as they apply to psychology will be explained in the next chapter.

Why do we sometimes find it so difficult to concentrate on the task at hand?

The experimental psychologist usually employs laboratory equipment of some kind. Fig. 1.1 shows an example of the kind of laboratory equipment he now has for registering the reactions of different parts of the body when an individual becomes even mildly disturbed.

FIGURE 1.1. Demonstration of how various bodily reactions (changes) are recorded in the psychological laboratory. Among the reactions recorded here are those of breathing, pulse, blood pressure, and skin temperature. (Courtesy of Albert F. Ax and Look Magazine.)

Physiological Psychology. There is no doubt that mental activity is dependent upon bodily structures and that it is most related to the nervous system, sense organs, muscles, and glands. Many psychologists believe that in the functioning of these organs will be found the most satisfactory explanations of behavior and adjustment. They want to know which centers of the brain are concerned with seeing, hearing, feeling, remembering, and thinking, and to know what kind of processes go on in those centers when those mental operations occur. They want to know what bodily mechanisms operate to motivate us to put forth effort and what ones enable us to have likes and dislikes and emotions. Others want to know what the glands have to do with our personalities.

Animal Psychology. Many psychologists prefer to make their investigations by using lower animals as experimental subjects. The favorite animal is the albino rat. Other rodents are sometimes used, also cats, dogs, fish, monkeys, and chimpanzees. Many other kinds of animals both high and low in the scale have been used as experimental subjects from time to time.

FIGURE 1.2. Demonstration of an experimental study of rat behavior. A sudden, strong jet of air stimulates the rat to jump from his perch. The rat chooses one of two windows, marked differently, into which to jump. If he chooses correctly, he finds it open and he lands gently behind it. He may then receive a reward such as food. If he chooses wrongly, he falls into a canvas below. With this simple apparatus the rat can be presented with problems that vary from quite easy to insolvable ones. (Courtesy of N. R. F. Maier.)

One general interest has been in the comparison of different species of animals with one another and with man so far as the presence or absence of certain mental activities and their efficiencies are concerned. What sensory equipment is present in the different species? Can lower animals learn, think, and reason? Does man have any of the animal instincts? Do lower animals have any human intelligence?

Since in so many respects lower animals behave like human beings (or should we say that human beings behave like animals?),

we can learn very much about human psychology by studying animals. The same principles that account for animal behavior seem to apply to a large extent to human behavior. This is especially fortunate, since lower animals are easier to control in an experiment and they can be subjected to situations that would be very unpleasant and perhaps insulting or dangerous to human beings. Where surgical operations must be performed in physiological studies, there is no doubt as to whether human or animal subjects should be used.

Fig. 1.2 shows one of many examples of how the psychologist investigates animal behavior.

Child Psychology. The study of the child is almost as old as the study of the adult. The educator has wanted to know with what kind of specimen he has to deal in his attempts to teach and to train him. The development of behavior in the child has been carefully charted both before and after birth (see Ch. III). There have been some general questions. To what extent is development determined by hereditary endowment and to what extent by environmental pressures? How can we promote the child's best development so that he will become a well-adjusted, happy, effective adult? All parents as well as teachers and others who deal with children should want to know the answers to this question. Fig. 1.3 shows an example of the kind of research study being made with children.

Social Psychology. It is recognized today that one of the most critical problems facing mankind is that of human relations. How can men live together in peace and in comfort, whether they face one another as members of an industrial organization, as citizens of a community, or as nations with very different ideas?

Although groups of people are composed of individuals, many new problems of behavior enter the picture where groups are concerned. The behavior of people in groups is different in many ways from their behavior when alone. What are these differences and how do they come about? How do groups form and why do they behave as they do? These questions apply to such groups as audiences, social and economic classes, mobs, armies, and nations. How are attitudes and prejudices toward

social groups, races, and social institutions formed and how can they be changed? What is leadership, how does it develop, and how can it operate effectively?

Some social psychologists are concerned today with problems of *group dynamics.* Roughly speaking, group dynamics means the interplay of forces within a group or organization. The psychological atmosphere is different in a group that is operated

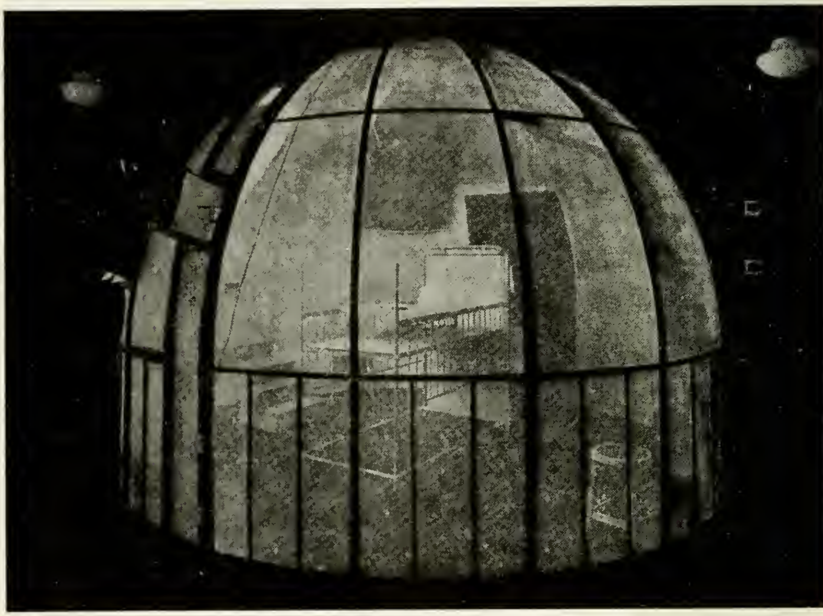

FIGURE 1.3. A view of the famous Gesell observation dome at Yale University. The infant placed in the crib can be observed from almost any direction. As different things are done to him, his reactions can be recorded in still pictures or on sound film. (From A. Gesell, in *An Atlas of Infant Behavior,* Vol. I.)

along democratic lines from that in a group that is operated along autocratic lines. Such groups have been set up in the laboratory in order to study the feelings and attitudes of the members and their productivities. Sound knowledge of inter-personal relationships should go a long way toward solving some of the social, political, and industrial problems of our time.

Abnormal Psychology. The investigator in the field of abnormal psychology is interested in all kinds of behavior that deviates in any way from the usual or customary. In extreme

departures from the common behavior, we find people who suffer from mental diseases. There are some with psychoneuroses, or what in popular language would be called nervous breakdowns. There are others who suffer from psychoses, many of whom would be called insane. The psychologist wants to know all he can about the symptoms of such diseases and what causes them.

Many more individuals suffer from minor maladjustments of one kind or another. Many are baffled by life's problems and do not know what to do or where to turn. The maladjustments may injure the person's physical health besides hindering his full effectiveness as an individual. They sometimes result in the person doing odd or unexpected things. Something of the varieties of maladjustments and their consequences will be discussed in Chs. VI and VII.

General Psychology. We have just seen some brief descriptions of special fields of psychology. What, then, is "general psychology," which is the title of this volume? In a college curriculum, general psychology is an introduction to all psychology. It includes the basic ideas that are more or less common to all the fields. It draws upon all the fields for information and provides a single foundation for them all. The frame of reference is the normal, human adult. While most of the information in the chapters to follow comes from the field of experimental psychology, you will find liberal references to the other fields also as sources.

Professional Psychologists

In recent years the recognition has been growing rapidly that there is a profession of psychology as well as a science of psychology. There was a time when psychologists were trained largely for the sake of training other psychologists. That time has definitely passed. It is safe to say that less than half the psychologists-in-training today are destined for teaching positions. The majority will be engaged in clinical practice, in vocational counseling and guidance, in industrial work, and in research outside of universities. They will be found in other occupations in which their unique technical skills are needed. They will be

found employed by governmental agencies, by industries, and by educational institutions. Some will be in private practice as clinical, vocational, or industrial consultants. What do these various kinds of psychologists do? The answer here must be very brief. Only a few examples can be given.

FIGURE 1.4. Psychologist administering the "Grace Arthur Stencil Design Test" to a child. (Courtesy of The Psychological Corporation.)

The Clinical Psychologist. The clinical psychologist is usually employed by such agencies as the Veterans Administration or the Public Health Service; by schools, colleges, or universities; or by guidance clinics. Some serve in hospitals and some are in private practice. The clinical psychologist's job is to examine, to diagnose, and to recommend or to apply treatment to people in trouble. His work comes close to that of the psychiatrist and the psychiatric social worker in many ways. He does not attempt to do all that the medically trained psychiatrist does, for example, the treatment of psychotic (insane) individuals. He works in

touch with medical cooperation where medical problems are involved. His activities may be confined to the giving of vocational guidance and counsel. In connection with industries, he may handle problems of employee maladjustment or he may be called upon to study an entire organization to find out why it is having management difficulties.

Personnel Psychologists. The term "personnel psychologist" is not a very common expression, but it covers quite a variety of individuals who are concerned in one way or another with the selection, classification, and training of people. These psychologists are found in connection with governmental agencies, such as civil-service examining offices; personnel departments of business and industrial organizations; personnel divisions of the armed services; and in student-personnel offices of colleges and universities.

Civil-service jurisdictions have continued to enlarge their activities and functions. As the art of examining, which depends upon psychological advances, has improved, the demand for psychologically trained individuals as civil-service examiners has increased.

The armed services during the recent war, and following the war, have generously supported research programs for the improvement of selection and classification methods. The mushrooming complexity of military operations and the great variety of skills required have intensified the need for assigning recruits to the kinds of training and work to which they are best adapted. In World War I, the typical psychological testing, with the Army Alpha Examination, required about 45 minutes of time for each soldier. In World War II, one branch of the service, the Army Air Force, allotted two full days of psychological testing to aircrew candidates before they were classified for training. Something like 600,000 men went through this routine examining program. The AAF also allotted much additional time for experimental testing before the men went into combat and after they returned from combat duty. In another branch of the service, the Office of Strategic Services, candidates for duty as secret agents were studied psychologically for several days.

College personnel services have shown considerable growth in recent years. It is not uncommon now for a college or university to devote two or three days of testing to its incoming students, or to continue such testing in connection with orientation courses. The objectives are to provide student advisers with a much better basis for educational and vocational guidance. Consulting services of trained psychologists are also commonly available to assist

FIGURE 1.5. Aviation Cadets taking group psychological tests in the Army Air Force during World War II. Approximately 600,000 young men took two days of tests preparatory to being classified for training as pilots, navigators, bombardiers, or other specialties.

students in maintaining good mental health and in developing desirable personalities. Among the most common problems that students themselves bring to the counselor are: lack of self-confidence, inability to concentrate, desire for a more pleasing personality, worry about being a success in life, fear of speaking out in class discussions, strained relations with members of the family, and worry over sex behavior. While there are common difficulties faced by many students alike, the successful treatment is usually an individual matter, requiring personal consultation. A knowledge of the basic principles of psychology should be a distinct help to the student in meeting some of these problems.

The public-school psychologist performs much the same duties at lower educational levels. There are now tests that can be used to help decide whether a child is ready to learn certain subjects or to undertake learning at successive levels. Besides teaching the three R's, modern educators have assumed some responsibility for the general development of a child's social and civic skills. Attention is given to the correction of faulty personality development. In such a program, there is need for repeated assessment of the child's growing abilities and for determining his achievement by improved methods which psychological knowledge has made possible.

Research Psychologists. Opportunities for psychologists in purely research positions have continued since the recent war. Much of this research is being done for military agencies. Problems of vision and of hearing are increased as the demands upon those senses become more exacting in the operation of complicated and split-second equipment. Problems of speech arise in connection with the various devices for communication. The invention of new equipment has pushed to the limits the powers of human individuals to operate it. Psychologists are assisting in the designing of new equipment so as to permit better human control and comfort in its operation. Problems of military personnel continue to call for solution. As practical and useful as present procedures are, there is always room for improvement. Recent experiences have shown how such improvements can be brought about. What was just said about personnel procedures also applies to procedures in clinical practice.

Both governmental agencies and private foundations have made available to universities funds for research which occupies the full or part time of many psychologists. The types of research projects undertaken are numerous. Noteworthy projects under investigation have to do with personal relations, particularly in industries, and with problems of leadership and management. The results should suggest new ways in which better human relations can be maintained not only in industries and in public agencies but also between racial and national groups.

Although not primarily a research instrument, the public-opinion poll should be mentioned. It can do much, of course, to

help solve some of the problems of human relations on the national and international scenes. In spite of many errors in conclusions drawn from polling results in the past, polls are here to stay. They serve very useful purposes in a democratic society. Knowledge of how masses of people are thinking and feeling on various issues in different countries, even though sometimes inconclusive, is of great value to those who must make policy decisions affecting masses of people.

Others Who Apply Psychology

All those who have to deal with other people in their daily work encounter psychological problems and most of them come to recognize this fact. The secrets of how to get along well with others and how to direct or to influence their behavior depend upon psychological knowledge. The various fields of modern life in which psychological knowledge is important will be reviewed very briefly.

Human Improvement. Fig. 1.6 is designed to show at a glance the various spheres of life in which a knowledge of the facts of human relations is most useful. Some fields attempt to change individuals for the better; to make them more effective and happy. Eugenics, the science of being well-born, tries to accomplish its results by controlling heredity. It asks of psychology what mental abilities and other traits are strongly determined by heredity and what ones are not. Education strives for improvement by a different route. Taking the individual as he is, with limited powers and traits, it tries, by proper stimulation, to develop to the utmost usefulness the powers and traits that he has.

Social work exerts its efforts both on the environment and on the individual in its endeavor to prevent dependency, delinquency, and crime. The social worker encounters a nest of psychological problems: the handling of clients; the recognition of signs of mental weakness and maladjustment; and the modification of the environment to reduce human misery.

Medicine and Law. Both law and medicine deal with human nature and its mental aspects. The wise doctor knows that he must help to restore to health a total personality as well as an

injured leg, an ulcerated stomach, or a tubercular lung. It has been estimated that from 50 to 60 per cent of all patients that come to the average medical doctor are in reality suffering from mild mental disorders rather than from purely organic disorders. The successful doctor satisfies because he administers to mental security and comfort as well as to physical well-being. Psychiatry, as a branch of medicine, is most intimately dependent upon psychological knowledge and methods.

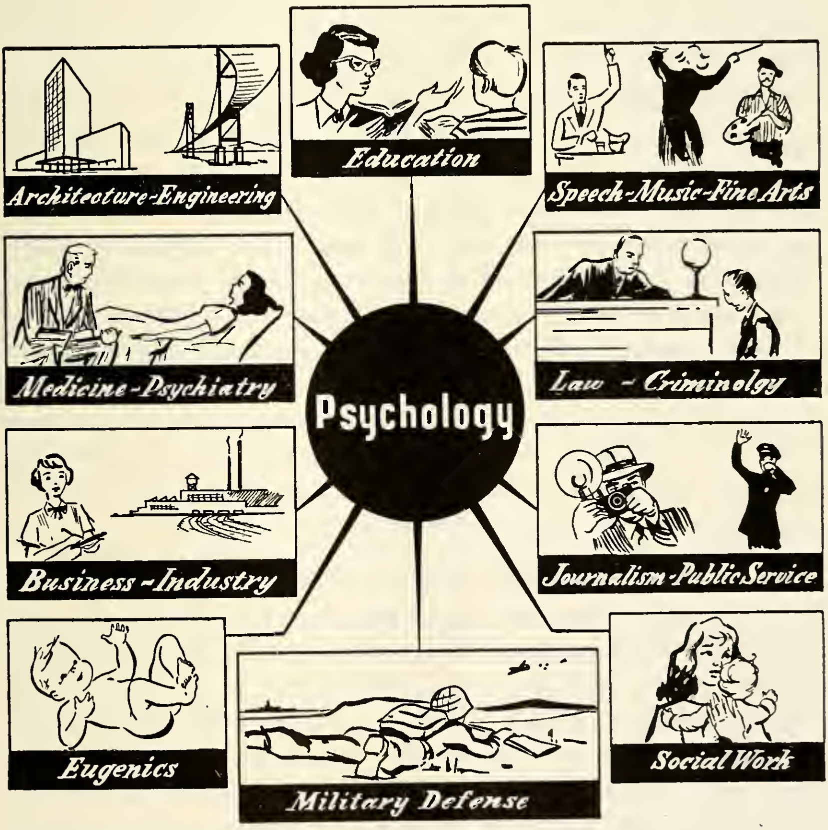

FIGURE 1.6. Fields of life that depend upon psychological knowledge for the successful solution of their problems.

The skilled lawyer who practices in our courts of law often encounters psychological questions. How well can the average witness observe an accident, a street fight, or a murder, and how

well can he remember and report the facts on the witness stand? What are the dependable signs of guilt and of falsehoods? Will a lie-detector work? Was the culprit responsible for his actions? What type of sentence will be adequate to impress the criminal and yet not make of him a confirmed hater of society?

The criminologist and those in charge of penal institutions face further questions. What type of man will make good on parole and what type should be permanently kept behind locked doors? What treatment should be accorded the drug addict, the alcoholic, and the sex violator? How can the criminal's attitudes and habits be changed so that he will not repeat his crimes?

Business and Industry. Business must attract customers and sell them goods and services or it cannot survive and prosper. Techniques of advertising and selling apply well-known psychological principles. An advertisement must attract attention, so the laws of attention are important; it must make people remember its product, so the laws of memory cannot be overlooked; and it must create a desire to buy, so it must appeal to human motives.

Both business and industry employ human individuals who must be selected, classified, trained, and motivated to give their best efforts to their work. The factors that make for the most efficient work with maximum satisfaction to both employer and employee and that prevent accidents, fatigue, boredom, and dissatisfaction must be recognized and taken into account.

Journalism and Public Service. The journalist in his hunt for news must appreciate the reader's interests both in the story and in how it is written. His stories deal predominately with human events, whether it be a minor incident or a "human interest" event or one of historical portent. His interpretations of human actions will be more penetrating because they are based upon a background of psychological knowledge and insight. The editor or columnist with a flair for propaganda must be master of the art of influencing public opinion.

Men and women in public office face problems of a similar nature. Where diplomatic relations with the public are important, many individuals master the art successfully through the years of trial-and-error experience. It cannot be maintained that

simply knowing all the available facts and principles of psychology would do as much for any individual; but it can be said that a little sure knowledge sometimes goes a very long way.

Architecture and Engineering. At first glance the gap between psychology and these practical fields seems almost impassable. But such is actually not the case. The architect must satisfy human wants with his plans by providing mental and physical comfort and by pleasing the esthetic side of our natures. Both architecture and engineering must take into account human habits and must plan for safety, for example, on streets and highways and in the human use of all mechanical contrivances. Problems of highway safety are now receiving much attention from both the human and the mechanical sides.

Psychology and the Arts. Among the arts we may list, in particular, speech, music, and the fine arts, including painting and sculpture. Speech is one of the most complicated and delicate of mental activities. Psychology touches the problems of speech at so many points that we cannot begin to enumerate them here. The same can be said for music. As for all the arts, the questions of appreciation, comprehension, performance, expression, and creation furnish many a psychological problem. These will be touched upon in the various chapters that follow.

Summary

Psychology can be described in terms of what psychologists do. Many psychologists teach in colleges and universities and, through their research investigations, they do very much to advance our knowledge of human behavior and human nature. The experimental psychologist studies the basic facts and principles of behavior, usually in a laboratory and with human adults as his experimental subjects. The physiological psychologist investigates the bodily structures and functions that seem most directly related to mental activity. The animal psychologist uses lower animals as experimental subjects, hoping thereby to learn much about human nature indirectly and economically. The child psychologist is concerned with the development of behavior in the fetus, infant, child, and adolescent. The social psychologist wants to find out how social objects and events affect our behavior

and how groups operate. Abnormal psychology is concerned with the odd, the unusual, and the bothersome aspects of behavior, looking toward the understanding of people in trouble.

There is a profession of psychology as well as a science of psychology. The clinical psychologist is concerned with the mental welfare of individuals. He deals with behavior problems and maladjustments. Personnel psychologists are concerned with problems of vocational adjustment of individuals. They attempt to find the best individuals for jobs and the best kinds of work for individuals. They serve in connection with institutions of learning as well as military and industrial organizations. Many professional psychologists now occupy research positions. They not only help to improve upon the procedures of the clinical and personnel psychologists but also aim to solve some of the larger and more vital problems of human nature.

The practical usefulness of psychology extends into many spheres of life and into many vocations, as well as into the personal lives of individuals, no matter what their callings may be. Properly applied, psychological facts and principles help to make people happier and more effective. Benefits of psychology follow, however, only in proportion as effort and wisdom are exercised in its application.

Questions

1. Explain the differences between "pure" and "applied" psychology as to interests, aims, methods, and goals.
2. Find and list names of special applied fields of psychology.
3. Select some field of life or some occupation and show briefly where psychological facts and principles apply.
4. To what extent are the following persons, if successful in their work, justly called "psychologists": auctioneer; salesman; advertiser; ward politician; warden of a prison?
5. Make a list of the kinds of jobs that psychologists are known to occupy. Describe the job very briefly if the title is not sufficient to indicate the major duty.

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* These volumes contain readings that supplement all of the chapters to follow as well as this one.

CHAPTER II

Psychology and Its Methods

From the first chapter you should have obtained a general, concrete idea of psychology by learning something about the activities of psychologists. In this chapter we will take a closer look at psychology itself and consider its aims, its relation to other sciences, and its methods. We shall first give a little more attention to the statement that psychology is the science of mental activities of organisms.

An Organism and Its Activities

An organism is any living individual, either animal or plant. It is an organized system of parts that ordinarily work together in a unified manner, all contributing to the welfare of the individual. If we take only a very brief inventory of its activities, we find that, among other things, it takes nourishment from its environment, it grows, it protects itself from damaging forces in the environment in which it lives, it reproduces, and eventually it dies. If it is an animal, it moves about, searching for food or for a mate, avoiding dangers and combating its enemies. Our interests in psychology are almost entirely restricted to animals, for plants show very little activity that we can call mental.

A further examination of what an organism does will show that in order to live it must breathe, and it must assimilate its food by the process of disgestion. Both food material and oxygen must be carried to all living cells throughout the body by means of the blood and its circulation. The same blood stream collects waste products that are eliminated by organs especially designed for that purpose. For all these activities there are special organs or systems—stomach, liver, heart, and lungs; digestive, respiratory, and circulatory systems.

Mental Activities. There is one system in particular that is of greatest importance for psychology. That is the nervous system. The nervous system, with the brain as its center in higher animals, is the chief basis for mental activity. So far as we know, mental activity such as we study in psychology cannot take place apart from nervous tissue any more than digestion can take place apart from digestive organs or circulation of blood apart from organs of circulation.

Some Mental Activities. What specific actions of the human individual would be regarded as mental by the average person? One thinks first of such things as sensing, perceiving, remembering, imagining, thinking, and the like. One might add to the list such things as wishing, desiring, feeling, loving, hating, resolving, and the like. Why does the average person regard these processes as mental? Probably because they cannot be observed directly by the outsider. They are the private property of the individual who engages in them, except as he expresses them by his face or his manner of speech. They also seem, for the most part, to be carried on without the agency of any particular, observable bodily organ, unless they be associated in a vague way with the brain.

The psychologist does accept such phenomena as belonging to his field of study, but not for the reason just given, and he includes a great many more activities within his field of investigation; activities that are decidedly more open to inspection by the outsider, such as talking, writing, walking, smiling, frowning, jumping, and running. In fact, he includes all kinds of muscular actions—activities that require the use of bones and muscles as well as nervous tissue. Actions such as these, more open to external observation, are called *overt* behavior. The kind of activities

mentioned earlier, not directly observable to the outsider, are called *implicit* behavior.

What Makes an Activity Mental? It is not the privacy of certain activities that makes them mental. It is not the fact that they are carried on by a supposedly immaterial agent known as the "mind." Nor is it because they are confined to the action of the brain.

If you examine the lists of mental activities mentioned—sensing, perceiving, remembering, imagining, thinking, wishing, desiring, feeling, loving, hating, resolving, talking, writing, walking, smiling, frowning, jumping, and running—what do you find them to have in common? One thing is apparent: *They refer to the relation between an individual and his environment.* Either they reflect the influence of the environment upon the individual or they imply the use of the environment by the individual or his adjustment to it. By "environment" is meant all objects and forces outside the individual's skin but within reach of his sense organs so that they can affect him.*

Sensing, perceiving, feeling, remembering, imagining, thinking, smiling, and frowning all show the effects of past and present environment. You cannot remember and recall anything except from your own past experiences. You cannot imagine or think without the use of facts recalled from your past. The acts of desiring and resolving point to future action leading to some desired goal or to some change in your environment. Reasoning and imagination may be brought into play to help you attain the goals you desire. Writing, talking, running, and jumping all serve to obtain your wants from your environment, or they are set in motion by what happened to you. *Mental activities, then, have in common the fact that they deal with the relationship between the individual and his environment.* By means of them the individual is affected by the world around him, and, in turn, he can obtain what he needs from it, or can protect himself from it, or can change it more to his liking.

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* Some psychologists as well as biologists speak of an "internal" environment as well as an external environment. The reason is that forces within the organism also stimulate sense organs and affect other cells directly. In most writings, however, the term "environment" refers to forces external to the organism.

There is still another fact about mental activities that distinguishes them from other things that organisms do. Remember that mental activities are *primarily* what the nervous system does. The nervous system is not only in touch with the outside world, but it also serves as a connecting link between parts of the organism. *This makes it possible for the individual to act as a unit.* Without this intercommunication among the parts, he would not be able to keep them working in step and to maintain a united front against the destructive forces around him. To a small extent, the blood stream also serves to unify the individual, since it carries messages in the form of chemical products throughout the body. Compared with the nervous system, however, it is very slow and limited in its communicating function.

Receiving communications from within the body as well as from without, the brain is prepared to take account of the conditions of both and to excite the individual to act accordingly. Bodily tissues make known their deficiencies of food, water, oxygen, and other materials by exciting the nervous system. Being irritated, the nervous system sets the proper measures in motion to supply the needed materials. The individual at this time reports that he feels hungry, thirsty, suffocated, and so on. Eating, drinking, increased breathing, and acts similar to them, result. If the desired objects are not at hand, searching and other acts of preparation follow. Thus, one part of the body is made to serve another, and all work together, usually to the advantage of the whole. All these activities, too, come under the heading of "mental."

Receptors and Effectors.—There are two essential links between an organism and its environment. First, there must be a way of receiving information from one's surroundings. This way is provided by our *receptors* or sense organs, including specially sensitized structures in the eyes, ears, nose, tongue, and skin. The forces that act upon the receptors are technically called *stimuli.* While, actually, the stimuli are in the form of light waves, sound waves, chemical change or other varieties of energy, always in complex patterns, it is also customary to name the stimulus as an object, for example, a doll held up before a baby girl, a ball thrown to a seven-year-old boy, a slap on the back, or a printed word.

What the individual does is known technically as the *response,* or the *reaction.* To an outside observer the response is usually a movement, involving muscular contraction or relaxation. Here, as in the case of the stimulus, only rather gross descriptions are ordinarily made. The response is described as an arm flexion, an act of running away, or a spoken word. These illustrations of a response all involve the use of the skeletal muscles, that is, those muscles that move the limbs, neck, or trunk. Other responses involve the nonstriped muscles of the viscera and other internal organs, and still other responses are in the form of glandular secretions, such as the flow of saliva or of tears or the secretion of a ductless gland, such as the thyroid, which releases its secretion directly into the blood stream.

The muscles and glands, because they are the organs of response, fall under the term *effector.* The effectors furnish our second link with the environment. *Mental activity, then, typically begins at the stimulation of receptors and ends at the response of effectors, with the nervous system furnishing the connecting link between them.* This is not the complete picture of an organism behaving in its environment, but it will serve as a simple skeleton to which we shall later give flesh and blood.

The Aims of Psychology

Prediction. The social benefits of a science follow from understanding. From understanding, first of all, comes the power to predict future events so that we may be prepared to meet them. In this connection one thinks first of the astronomer's ability to predict the time of an eclipse. Perhaps one thinks next of the chemist's ability to predict that when two compounds are mixed in certain proportions and heated to a certain temperature, a certain new compound will result. In the field of medicine one can predict the time when a wound will be healed, if he knows the size and shape of the wound and the age of the patient.

Predictions of the same sort can be made about mental activity. The individual's actions of the moment are the outcome of a great many conditions or factors. It is the creed of the scientist that if we knew all the laws of human behavior, and if we knew the factors influencing an individual at the moment, we should

be able to predict exactly what he would do in the next moment. Does this idea make the human individual simply a puppet in the hands of his environment? Not at all. The secret of the matter is that there are strong determining factors within the organism itself, as well as outside the organism, and the more complex the organism, the more important are these internal factors. To live at all means some degree of self-regulation, some degree of resistance against the environment, as well as a measure of independence of the environment.

The Prediction of Behavior. What factors must we know in order to predict what an individual is going to do next? At this early stage of acquaintance with psychology, we can list the factors only in very general terms. We may distinguish between two major classes, those outside the organism and those inside. External to the individual is the stimulus, which has already been mentioned. But the stimulus is not the only external influence. An individual rarely if ever reacts to only one force or object at a time. The stimulus is merely that part of the total environment that seems to the psychologist, as a human observer, to be the most effective element in obtaining a reaction from the organism under observation.

A stimulus always arises on the background of a larger pattern of forces or objects, which we call the *situation.* What particular reaction is aroused by the stimulus depends very much at times on the situation. For example, your response to a lion met face to face in the street would be very different from your response to the same lion met face to face with iron bars between you and it. The relative importance of total situation and stimulus varies from time to time; sometimes the one is all important, and sometimes the other, and again both share about equally the responsibility for your reaction. At any rate, we react to patterns of stimulation, and rarely if ever to a bit of energy taken alone.

In addition to the external forces provided by the situation, the response is determined by the individual. We must therefore know our individual. Is he canine, feline, or human? Is he old or young, male or female, bright or dull? We must know more. What is his *set* at the moment, that is, what is he prepared to do at the moment the stimulus comes? Is he awake or asleep,

hungry or satiated, alert or relaxed, rested or fatigued? What is his mood, or emotional state? Is he bent on reaching a goal to which the stimulus is irrelevant, or a goal for which the stimulus may be used as a means to an end? It would also help us to know what he had done with similar stimuli in the past, that is, what specific habits he may have developed in response to this stimulus or to one for which it may serve as a substitute. This brief and general list should be sufficient to impress one with the great intricacy of casual factors in human behavior, and also with the great importance of the internal factors.

It must be admitted, of course, that we are still a long way from knowing all the laws of behavior. We also lack the power of knowing all the factors at the moment that are influencing an individual. Perfect knowledge and perfect prediction are too much to ask of a scientist in any field, least of all of a psychologist, who deals with one of the most complicated of all units. Even the astronomer, whose predictions are very exact, misses an eclipse by a second or two now and then, and when a new comet nears the earth, he is often uncertain as to just what will happen.

Every prediction has its margin of error. The predictions of a psychologist, like those of the weatherman, are usually subject to a wider margin of error than those made in the more exact sciences. But this does not destroy their usefulness as predictions. Some foreknowledge of results is much better than none at all. No one would think of giving up weather predictions just because the weatherman is frequently mistaken. More often than not he is near the truth, and the more information he gains about the weather and its habits, the smaller will his margin of error become. The same holds true for predictions of a psychological nature.

Some Typical Psychological Predictions. As yet, predictions of human performance can best be made only in general terms. The forecast of all the specific details in a given situation is beyond present possibilities. For example, we find that young Donald scores exceptionally high in certain tests of abilities necessary for musical performance. We may then decide that he can be trained to succeed as an outstanding musician, if he will put forth the effort. We cannot predict from this information alone that he will play Rachmaninoff's famous Prelude in any particular

manner or any particular program without knowing many more significant details. For the purposes of deciding whether Donald should or should not devote hours of effort to music, our prediction is adequate.

Other questions of social importance can be answered similarly. Let us assume that we know the intelligence-test scores of three boys, Hans, Reginald, and Frank, all six years of age. Unless their environments change radically, we may look for Hans to be slow in school and to reach his limit for school education at the sixth-grade level; Reginald will probably reach his limit of profitable schooling in the twelfth grade; but Frank can extend his school training as far as he chooses to continue. All of these predictions, of course, have their margins of error.

More specific predictions than these can be made, as the reader will find in his further excursions into psychology. Knowing our individual and the condition of his eyes, we can predict what color he will see when a certain light stimulus is presented to him. Knowing an individual's ability to learn, we can estimate his level of skill, after a certain amount of practice, and we can forecast how rapidly he will forget without practice, and how much practice would be needed to regain his original peak of efficiency.

Control. Understanding of human nature also enables us to control, to some extent, the lives of others, as well as our own. For if we know the causes of an action, all we needed to do is to manipulate the causal factors, and the result may be expected. The teacher wishes to cause her pupils to learn; the salesman tries to get his customer to sign on the dotted line; the minister exhorts the sinner to reform; the circus barker uses his bagful of tricks to start a stream of humanity into his sideshow. All these persons are obviously attempting to change the actions of other individuals.

The Relation of Psychology to Other Sciences

It was indicated before that psychology is intimately related to physiology. In fact, it is sometimes difficult to draw a sharp line between them, for both deal with activities

of organisms. One difference is that psychology emphasizes the behavior of the individual as a whole. There are other sciences, however, that deal with actions of the individual as a whole. These are the social sciences, including sociology, economics, and political science. Further distinctions and relations must therefore be drawn. These can be best understood if we take a bit of time to consider the whole structure of the sciences. The interrelationships of the sciences, as the author thinks of them, are illustrated in Fig. 2.1.

The Structure of the Sciences. We may think of all the sciences as forming a solid structure, with a broad foundation, two columns, and a capstone or superstructure. At the foundation are physics and chemistry. With the exception of astronomy, they are the oldest and most exact of the sciences. The natural units of physics and chemistry are the molecule, the atom, and still smaller particles—electrons, protons, neutrons, and mesons. The universe is said to be composed of these elemental units. All phenomena are manifestations of these units in their infinite variety of groupings, organizations, and interactions. Physics and chemistry study the universe, not caring particularly whether its materials form a stone, a rose, a human being, or a heap of dust. Very appropriately these sciences are regarded as the foundation of all other sciences.

Sciences of the Environment. The column at the left in Fig. 2.1 represents those sciences that study the universe, and in particular the earth, as the home of man. They are concerned with man's material environment, to which he must adjust himself and which he may exploit to his own advantage. The more he knows about his environment, the more independent he is of its dangers and its discomforts, and the greater use he can make of it. His most immediate contacts are with the gross objects in that environment. A more exact study of those objects and their behavior leads him into the sciences of physics and chemistry. Thus the "environmental" sciences are continually going back to physics and chemistry in order to explain their phenomena.

Sciences of Life. The column at the right represents a very logical sequence from the lowest living forms to the highest,

leading step by step from the physical sciences to the social sciences. Botany, dealing with plant life, and zoology, dealing

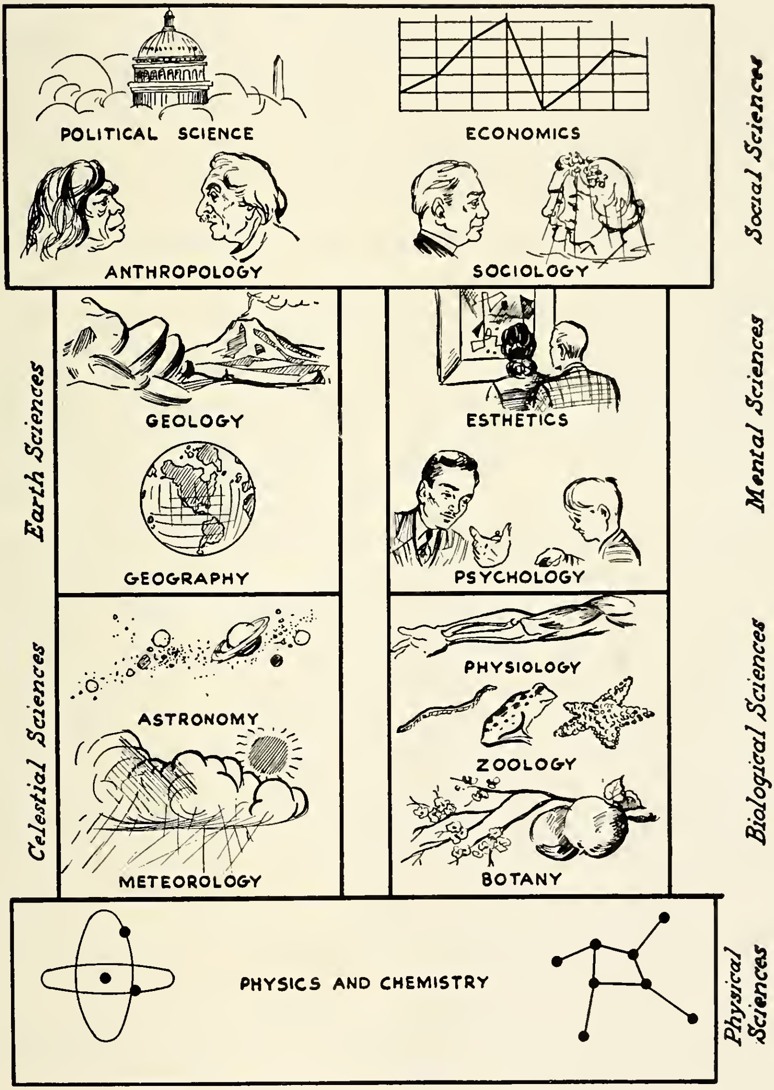

FIGURE 2.1 The structure of the sciences.

with animal life, have as their natural units the living cells, organs, and total organisms, each a higher organization of the unit preceding in the list.

The Mental Sciences. Along with psychology, esthetics is listed as a mental science. The inclusion of esthetics must be with some hesitation. Esthetics has been concerned primarily with the study of beauty. Insofar as it is devoted to answering the question of what should be the *standards* of beauty, it is not a natural science. Science is not adapted to giving direct information about standards or values of this kind. On the other hand, things are beautiful or not according to how people react to them. Esthetic reactions are phenomena of behavior, hence are subject matter for scientific description. It is in this sense that we can speak of a science of esthetics. As a science, it might well be regarded as a special branch of psychology.

The Social Sciences. The social sciences deal with the most complex phenomena of all. It is difficult enough to understand the human individual apart from his social behavior; it is all the more baffling to try to bring order and simplicity into the intricate patterns of social interchange. The social sciences rest on both columns of our symbolic structure (see Fig. 2.1). Anthropology, the science of man, economics, and, to some extent, political science, cannot understand their phenomena aside from the geographical factors that affect human beings. None of them, particularly sociology, can afford to ignore the principles of individual behavior, as revealed by psychology. The behavior of men who form and maintain social institutions obeys the laws of mental life in general. Economic behavior is but the attempt of man to gratify certain needs of life by the process of interchange of commodities and services with others. Political behavior is but the attempt of man to organize and to regulate masses of his own kind by means of organized government, to the mutual advantage of himself and others. Economic and political behavior, too, are but special expressions of human mental life. To this extent, psychology may be regarded as basic to the social sciences, just as physiology is basic to psychology, and, in turn, as chemistry is basic to physiology.

How Psychology Discovers Facts

The critical student of today is not willing merely to take the conclusions of science that are handed to him. This

attitude is a most hopeful sign. A good student of science, like a good scientist, is "from Missouri"; he wishes to be shown *how* facts and conclusions are arrived at. It is most important that the student of psychology be aware of its methods, for the reason that a distinction must be drawn between common-sense psychology and scientific psychology. This will be difficult enough at all times, but it will help some to know the difference between scientific and unscientific methods in getting psychological facts.

The "Armchair" Method. One of the oldest and least scientific methods depends almost entirely upon speculation and conjecture. This is the traditional method of the philosopher, the village sage, and of the charlatan character-analyst. It depends upon a minimum of observation and a maximum of speculation. It is the method of those too lazy or too lacking in interest to gather the facts systematically or otherwise, and who have an exaggerated faith in their own powers of reasoning to solve all problems and to answer all questions.

A very appropriate example is the case of a certain writer on the reading of character from the shape of head, face, body, and hands. One of her arguments is as follows: Blonds come from northern climates where life is difficult and the environment is stimulating. Therefore they have evolved into a type that is aggressive, active, restless, fond of variety, practical, matter-of-fact, and material. On the other hand, brunets have evolved from ancestors who lived in the warm climates where life is easy, monotonous, and not exacting. Brunets are therefore slow, easy-going, hateful of change, introspective, philosophical, and religious. The blond, consequently, is supposed to be found in larger numbers among the speculators, promoters, organizers, advertising men, traveling salesmen, while the brunet should predominate among the plodders, the planners, the scientists, administrators, and the like. On the very slim basis of a single fact, a whole list of traits is dogmatically assigned to blonds and another list to brunets.

No doubt the less scientific individual will either be swept into an attitude of belief by the seeming plausibility of the argument, or, if he disagrees with the assertions about blonds and brunets at all, he will be likely to meet them in one of two ways. He will argue to the contrary, with probably little better

basis than that of his opponent, or he will cite instances of people he knows who are exceptions to the supposed rules.

Present-day psychologists do not shun entirely the use of speculations. They indulge in speculations on two occasions. One of these occasions is when they are preparing to make some new observations and the other is after the results are in and interpretations are in order.

The Anecdotal Method. This method is seen in the citation of specific instances of casual observation in order to prove a point. Suppose the question arises as to whether horses can distinguish colors or whether they are completely color-blind. One member of the group discussing this question says he is sure horses can discriminate between colors, because he knows a milkman's horse, who, when left to his own guidance, manages to obey the traffic signals. Approaching a red light he stops and waits for the lights to change; approaching a green light he continues on his way. This is enough to convince the uncritical person that horses can tell the difference between red and green. But is it really convincing? The student with imagination thinks of reasons why this one instance does not prove the rule. The horse might have responded to other traffic and not to the lights at all. He may have learned to react to the positions of the lights and not to their colors. He may have learned to respond to differences in brightness (one light being lighter or darker) rather than to colors as such. These possibilities and others being ruled out, not by argument but by known facts of the case, we may well conclude that the horse can discriminate between red and green, but only then. Before generalizing by concluding that all horses can discriminate all colors, we should have to try out other horses and other pairs of colors.

The Experimental Method. The most dependable way of obtaining facts is the experimental method. Briefly, this means the observation of facts under controlled conditions. Suppose we had taken seriously the assertions of the character analyst concerning the differences between personality traits of blonds and brunets. Suppose we wished to put those assertions to the test of careful observations. We thus treat each assertion as merely

a *hypothesis.* A hypothesis is a guess as to some genuine relation or fact that we expect to find verified when further observations are made. The guess is, of course, based upon some preliminary observations or upon a rational basis, usually upon both.

A Scientific Study of Blonds and Brunets. How should one proceed to test the hypotheses concerning the supposed personality traits of blonds and brunets? One could take notebook and pencil in hand and set out to find distinct blonds and brunets. When either type was found, one could determine whether the individual had the traits demanded by the hypotheses. To assure a generous sample of both blonds and brunets, one could continue until two hundred of each type were studied. The proportion of the blonds who were judged as aggressive could be tallied and also the proportion of the brunets, to see whether there is a significant difference in the expected direction. The two classes could be compared similarly in other traits in which they are supposed to differ.

We still, however, do not have a scientific experiment. Suppose, by chance, the investigator of this problem collected mostly males among his blond group and mostly females among his brunet group. Suppose, as is often true, the average male is more aggressive than the average female, in the population being studied. It would therefore appear that blonds are more aggressive than brunets, which would look like a verification of the hypothesis. The trouble is that the factor of sex difference has not been controlled or kept constant. In an experiment on this problem, there should be an even number of the two sexes in the two groups or the two sexes should be treated separately. The factor of age should also be controlled, lest one group have a higher average age than the other. Should this occur, a difference in personality caused by a difference in age might give the false impression that it is due to the blond-brunet difference. Other factors that should probably be controlled include educational level, socio-economic level, and amount of vocational experience. Before we can draw conclusions that are beyond contradiction about personality traits associated with dark or light hair and skin, we must have two groups of in-

dividuals who differ, if possible, only in the one respect, and in whatever traits follow from that difference.

An Experiment on the Causes Affecting Scholarship. Consider another example, this one from educational psychology. Suppose we wish to know the causes of high scholarship as measured by grades earned in college courses. We suspect that among the determiners of scholarship are level of intelligence, sex of the student, amount of study, time given to student activi-

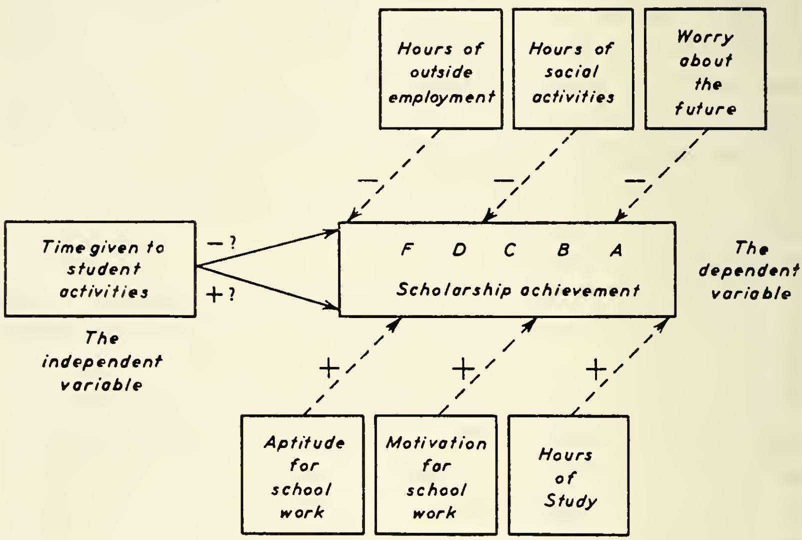

FIGURE 2.2. The general plan of an experiment, showing how the "dependent variable"—in this case scholarship as indicated by grades in school courses—is possibly affected by a number of "independent variables." One of the independent variables, time devoted to student activities, is allowed to vary systematically while the others are held constant.

ties, time given to self-support, and number of course units carried. It is customary to call the effect or result, in this case scholarship record, the *dependent variable.* The entire set of relationships is illustrated in Fig. 2.2. As some of the causal factors increase, they tend to raise the level of scholarship. As some of the others increase, they tend to lower the level of scholarship. The former factors are given plus signs in Fig. 2.2 and the latter are given minus signs, to show our expectations. Until we complete the experiment we cannot be sure which

ones have positive effects, which have negative effects, and which have neither.

We must study the effect of each factor in turn, and while we are studying its influence we must keep all the other factors constant. For example, while studying the effects of time devoted to student activities, we choose students who vary all the way from none at all to those who spend a maximum amount of time.

Ideally, of course, we should use the same students who in different school terms indulge in different amounts of student activities, everything else remaining the same. Actually we cannot satisfy this ideal, so we do the next best thing. We use students of comparable abilities (and who are also comparable in other respects) who vary in amounts of time in student activities. We call the factor of student activities the *independent variable.* It is the variable that the experimenter varies systematically, other things being equal, watching for resulting charges in the dependent variable. Then, if there is a consistent increase or decrease in scholarship rating that follows along with an increase in amount of time spent on student activities, we can conclude that there is a real connection between the two. We can decide that any apparent agreement between scholarship and time spent in student activities is not due to any of the other factors. We could say that, other things being equal, the more time a student spends in student activities the higher (or lower) will be his scholarship.

Reaction-Time Experiments. How quickly can an individual make a reaction to a stimulus for which he is prepared? This question has brought about many an experiment in psychology. A simple form of the experiment is as follows. The subject whose reaction time is to be measured is seated comfortably in a chair. His forefinger is poised ready to press upon a telegraph key. He is instructed to press the key the moment he hears a click. By means of a delicate clock, the amount of time elapsing between the stimulus and the response can be measured very accurately, in fractions of a second. This is possible because the moment the experimenter presses his key to produce the click, the clock starts, and the moment the subject presses his key in reacting, the clock stops.

Suppose that, for the moment, we are interested in knowing whether the *kind* of stimulus makes any difference. Will the subject react as quickly to a flash of light as he will to a sound? To return to the previous description of an experiment, what is the independent variable, and what is the dependent variable? In this experiment, the kind of stimulus, whether it is a light or a sound, is the independent variable. The reaction time is the dependent variable. Factors that we try to hold constant when we are applying either kind of stimulus would include the strength

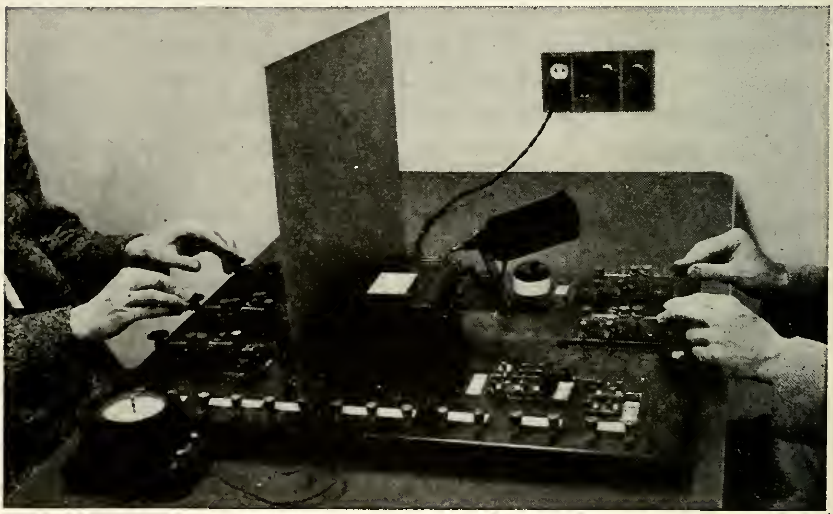

FIGURE 2.3. A typical set-up of apparatus used in a reaction-time experiment. Various kinds of stimuli—light, sound, touch—can be administered to the experimental subject who responds by pressing a key.

of the stimulus. We would not employ a strong light and a weak sound, or a weak light and a strong sound, for fear that strength of stimulus, as such, would affect the reaction time. Effort is another factor that we would try to control within the subject himself. We would impress upon the subject the importance of giving maximal attention to the task, in both cases. There are other factors to deal with, too numerous to mention here.

In this experiment we would not be contented with just two trials, one for the sound stimulus and one for the light. It is true that, for the normal subject, most of the reactions to

sound will be quicker than those to light. But, occasionally, he will have a quicker reaction for the light stimulus than for the sound. For example, the same individual who has made ten reactions to each stimulus might have reaction times as follows (they are given in terms of milliseconds, or thousandths of a second):

To light: 192, 187, 202, 183, 194, 201, 178, 183, 191, 187.

To sound: 165, 170, 162, 158, 174, 158, 161, 186, 163, 153.

While the times for reactions to light are mostly longer, three of them (183, 178, and 185) are shorter than the longest one for reaction to sound. While the reactions to sound are mostly shorter, one of them (186) is longer than the shortest reactions to light. In other words, single reactions to sound are not always shorter than those to light. We therefore resort to a comparison of the two averages. Add up the first row of numbers and divide by 10, and the average is exactly 190. Do the same for the second row, and the average is 165. We can now say that for this subject the average reaction time to light is 25 milliseconds longer than the average reaction time to sound. We take this to be the typical difference between the two kinds of reaction. This subject runs true to form, that is, most individuals show about the same average difference between reaction times to these two kinds of stimuli. Average reactions to touch stimuli are usually still quicker than those to sound.

The experiment could be varied in a great many ways. The independent variable could be the strength of stimulus. Using a sound that varied in ten to twenty steps all the way from a mere click to a gunshot, will there be a difference in average reaction time? As might be expected, the stronger the stimulus, the shorter the reaction time; the two variables are inversely related, in that, as the stimulus increases, the time of reacting tends to decrease. We might ask whether reaction time changes with age, and then the factor of age becomes our independent variable. Experiments show that the reaction time to the same stimulus decreases with age during childhood and youth, comes to its minimum in the early twenties, and later increases during middle age and beyond. The stimuli might be changed from simple

lights and sounds to letters, spoken words, or printed words. The reaction movement might be varied to use any particular muscle groups, including the muscles of speech. In fact, reaction time can be measured for almost any kind of stimulus followed by almost any kind of response, with systematic variations in the stimulus and with various degrees of learning or practice of the stimulus-response sequence in question.

Statistical Methods. Even the best experiment must be repeated a number of times in order to be sure that a similar result will be obtained under the same conditions. The more often the outcome repeats itself the more certain we feel that it will always so occur. Most results are tallied and summarized before conclusions are drawn. Here statistical methods come into use. It is very difficult in psychological experiments to know beforehand all the causal factors. It is very difficult, many times, to control all of them even if we recognize them. Results are not thoroughly consistent because of this. Statistical methods, fortunately, enable us to decide how much we can depend upon our results, even when we have not recognized all the causal factors and have not controlled all of them.

Not all questions about mental life can be put to experimental test as yet. This is even more true of questions arising in the social sciences. In either case, all we can do is to gather data, submit them to statistical analysis, and draw the best conclusions we know how. In other words, there are many investigations that are almost purely statistical in nature, for the experimental controls are far from complete.

Clinical Methods. Clinical psychologists were mentioned in the first chapter. To the clinics come individuals of many kinds. Many different procedures are employed in diagnosing and treating cases. There are certain standard procedures, however, that are utilized with many patients. Some of these are standard psychological tests. One test may be given to determine the level of intelligence, another to determine the level of educational achievement, and still another to measure certain personality traits. Detailed records are kept for each person who is served

by the clinic. Such a record usually includes a *case history* of the individual.

A case history contains systematic information of the individual's past. The facts are obtained from parents, teachers, social workers, and others who have known the person. While the primary purpose of such information is to find some course of treatment that will aid the individual in adjusting himself more adequately to life, the data often throw light upon general questions of a psychological nature. Like facts gleaned from medical practice, in themselves they do not settle the answers to problems, but they suggest important hypotheses upon which the more valid methods of experiment and statistical analysis can be focused.

Genetic Methods. Genetic problems are those having to do with growth or development. We not only want to know what people are like but also how they got that way. This means that we need to study individuals day by day, month by month, and year by year, noting changes that occur in them. Test procedures are valuable in this type of study. The growth and decline of any abilities for which there are systematic tests can be followed up by means of tests.

Direct observation, either with or without experimental control, is another approach. At a nursery school where children from 2 to 5 years of age come every day you may find a psychologist, stop-watch in hand, pencil and notebook nearby, jotting down notes about Jean or Robert day after day. A one-way vision screen sometimes separates child from observer so that the child may be observed without his realizing it. The special problem might be the development of participation in social behavior, of self-reliance, or of the child's fear or anger responses. The result is a running picture of the growing child and his behavior. Motion-picture records are sometimes kept, some with ultrarapid camera to make possible the analysis of quick-moving behavior into its constituent patterns.

The experimental and statistical methods are often brought into genetic studies. For example, the psychologist might be interested to know what effect a certain kind of treatment has on the development of aggressiveness in a too-submissive child,

Two matched groups of children of similar age would be selected, both with about the same average "score" on the aggressive-submissive scale. One group is given the special training and the other not. The first is known as the *experimental* group and the latter as the *control* group. Tests of the aggressive-submissive trait would be made from time to time and the two groups would be compared. Any significant difference could then be attributed to the special training.

Summary

Psychology is defined as the science of mental activity of organisms. Mental activities are distinguished from others by the fact that they tend to unify or integrate the individual and to refer to the interplay between the individual and his environment. Two connecting links between the individual and his environment are his receptors, or responding structures, and his effectors, including muscles and glands.

Like other sciences, psychology aims to understand its subject matter thoroughly, with emphasis upon the human individual. From understanding follow the power to predict and the power to control human actions.

Among the sciences, psychology is most intimately related to physiology and zoology on the one hand and to the social sciences on the other. It depends upon physiology for the explanation of many of its facts, because mental activity depends upon bodily structures. In turn, it is basic to the social sciences, because social phenomena represent various types of human behavior, for which there should be psychological explanations.

There is an important distinction to be made between scientific and unscientific methods of discovering psychological facts. We cannot depend upon pure speculation or upon casual, everyday observations of human and animal behavior to give us valid facts about mental activity. The most reliable method for uncovering such facts is the experimental method, in which observations are made again and again under controlled conditions. When we cannot make experiments we resort to facts obtained from a systematic collection of data—for example, from clinical

practice. Statistical procedures help us to decide what data mean, and what they tend to prove or fail to prove.

Questions

1. Draw up a list of human activities in which psychology is especially interested, a second list in which physiology is especially interested, and a third list in which both psychology and physiology are interested.
2. To what extent would psychology be interested in plant life?
3. Show that a physiologist, a psychologist, and a sociologist would all be interested in a study of the art of public speaking.
4. Give arguments for and against classifying psychology as a biological science, as a social science, and as an independent science.
5. Give some examples of predictions of behavior that you or others have recently made and try to point out the bases on which the predictions were made.
6. Give some examples of the control of behavior that you have observed recently. What knowledge or methods were used? Try to explain why they worked or failed to work.
7. Give some examples of economic and political behavior and suggest wherein a knowledge of psychology would help to understand, predict, or control the behavior cited.
8. Design a brief experiment to show whether long lines of print are better or worse than short lines for efficient reading. What variables would you need to keep constant? What is the dependent variable and what is the independent variable?
9. Suggest how the problem in question 8 might have been attacked by the "armchair" method and by the "anecdotal" method.

General References

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CHAPTER III

An Organism Develops

IN ATTEMPTING to understand an adult human being and his behavior, or to understand a youth or a child, for that matter, it is always illuminating to see how he got that way. In this chapter we will take a quick look at the human organism, at least those aspects that are important for behavior, and at the way in which a human individual grows. We shall note something about the behavior of the individual before his birth and after; how his behavior develops through the processes of maturation and learning; and how his heredity and his environment contribute to making him the kind of person he is.

The Nervous System

Mental activity, or behavior, is so intimately connected with the brain, in fact with the entire nervous system, that it will pay us to examine that system before going further. Our inspection will be only a general one, with an emphasis upon those parts that seem more significant to the student of psychology.

It was stated before that mental activity has two uses: (1) To unify the individual, and (2) to adjust him to his environment. The nervous system is the very intricate communication device that makes both of these goals possible.

The Central Nervous System. The major part of the communication is carried out by means of the central nervous system. This system is composed of the brain, the spinal cord, and the nerves extending from them. The general plan is shown in Fig. 3.1. The brain and spinal cord act as nerve

FIGURE 3.1. A general view of the central nervous system. (After H. N. Martin, in C. E. Skinner, *Readings in Psychology*, Farrar and Rinehart, Inc.)

centers, receiving "messages" or impulses coming in over the *afferent* or *sensory* nerves, and sending impulses out over the *efferent* or *motor* nerves. The spinal cord and much of the

lower part of the brain also serve to carry impulses to and from the higher brain centers. Within the nerve centers are the mechanisms for receiving and sending, and for directing incoming and outgoing, impulses.

We cannot say that every stimulus obtains an immediate response. It may set off a response that is delayed for a few seconds, for minutes, or even for longer time intervals. It may not arouse any observable response at all. But the typical pattern of any sample of behavior contains the following sequence: (1) a stimulus, on the background of a total situation; (2) excitation of receptors or sense organs; (3) ingoing impulses over afferent nerves; (4) a "choice" or adjustment in some nerve center or centers; (5) outgoing impulses over efferent nerves; and, finally, (6) the response of effectors. This formula implies that the brain itself initiates no activity; that it lies in wait for something from outside itself to stir up activity. This has been the prevailing belief, but it may not be the entire story, as we shall see in connection with the phenomenon of "brain waves," which are described later in this chapter.

The Autonomic Nervous System. In addition to the central nervous system, and attached to it, is the autonomic system. This system is a link between the central system and the internal body organs, particularly. Its special importance for psychology is in connection with emotional behavior, which will be treated in Chapter VII. The autonomic system is described there.

The Receptors. Every kind of receptor, like any bodily organ, is made up of cells. Only a limited number of these cells are genuine *receptor cells,* that is, are capable of responding to stimuli and of sending impulses toward the nerve centers. For example, a large part of the eye or the ear is merely *accessory apparatus* whose business it is to take the energy supplied by the environment and to arrange it into patterns of stimulation to be applied to the receptor cells. The accessory apparatus of the eye focuses an image of the environment upon the sensitive retina at the back of the eyeball. The retina contains thousands of receptor cells packed very close together. Each sends its own "message" inward toward the brain. The brain must take the

thousands of impulses coming into it at the moment and create the picture that we actually see.

Every kind of receptor is designed to be supersensitive to one kind of physical energy, and to be rather insensitive to other kinds. The receptor cells in the eye are supposed to be especially responsive to light waves, though it is quite probable that they do not respond directly to light energy. It is thought that light first affects chemically some material that surrounds the receptor cells, and that these chemical changes actually cause the receptor cells to act. While the internal parts of the ear are said to be supersensitive to mechanical vibrations, even here it is possible that the vibrations must first be transformed into chemical effects before the receptor cells can start impulses going toward the brain. The receptors for smell and taste respond to chemical effects from substances that come into direct contact with them.

The Nerve Impulse. When you accidentally jab your finger with a pin, and a sudden sharp pain warns you of the injury, the pin does not arouse a pain immediately in the finger; no pain is carried to the brain; and there is no pain in the brain. There is pain in your finger; that cannot be denied. But how does it get there? What actually travels from your finger to your brain? What happens in the brain to produce the pain you feel in your finger? Could there have been any pain in the injured finger without the cooperation of the brain and its nerves? These are questions that will occur to the inquiring student. We cannot as yet answer all of them, but we are sure of the answers to some.

An Impulse Is a Kind of Energy. Suppose that we could open up one of the nerves that connects finger with brain, pull out for inspection a single nerve fiber and examine it while pain is going on in the finger. What could we see? We should find, by using the proper instruments, that in response to the injury the nerve fiber is active because it gives off a slight amount of heat; it uses up a trifling amount of oxygen; and it gives off some carbon dioxide. This happens when all cells do their work. There is nothing new about this. Chemical tests would show that there had been chemical changes, and other tests

would show that there had been some slight fatigue, in that the fiber would not do as much work later as it did when first stimulated.

The most interesting facts come to light if we attach a very sensitive galvanometer to the acting nerve fiber. We find two important facts: (1) That the nervous impulse is an electrical phenomenon, or at least electrochemical, and (2) that there is not a steady, continuous flow of electrochemical changes along the fiber—the flow is intermittent. There is a succession of discharges sweeping along the fiber. The number of discharges per second may be as few as 10 or as many as 100 or more. [1] *

Impulses All of One Kind. The discharge over a single fiber is of the same kind of energy no matter where it is found; whether in a sensory or motor nerve; whether in the optic nerve or in the auditory nerve. How is it, then, that some impulses give us colors and others sounds? Why do some result in conscious experience while others result in muscular contraction without consciousness? The explanation is that the result depends upon where the impulse is going. Impulses arriving in the higher brain centers give rise to sensations. If they arrive at one region in the brain we see lights and colors and objects; if they arrive at another place, we hear sounds. If they go more directly through lower brain centers and merely proceed outward into motor nerves, we are likely to get movements without sensations accompanying or preceding them.

The Speed of Impulses. The speed of the nervous impulses has presented an interesting question. At one time it was thought that they traveled at lightning speed. Now we know that they travel more slowly; much more slowly even than an ordinary electric current, and this in turn travels much more slowly than light or radio waves. The speed depends upon the diameter of the nerve fiber. In man the maximum speed is about 100 meters per second. Other speeds vary on down to one-half meter per second in the smallest fibers. [2]

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* Numbers like this [1] throughout this volume indicate references listed by number under "Special References" at the ends of the chapters.

Responses of the Motor Apparatus. Muscles contract when receiving impulses from motor nerves. A single motor fiber may activate as many as 150 muscle cells or more. A muscle may be kept in a state of continual or *tonic* contraction by 10 discharges per second from the nerve fibers. When we are awake and alert most of our skeletal muscles are kept in this mildly contracted or tonic state. This maintains our bodily posture, sitting or standing. When we move a limb the frequency of discharge from each single nerve fiber usually lies between 10 and 30 per second, though under vigorous contraction the frequency may rise to 50 per second and higher. Most muscular responses are complex patterns of contractions in related muscle groups. The coordination of these contractions into well-regulated patterns with proper timing is the work of the brain.

Glandular Responses. Efferent nerves also activate the glands, including those with ducts, like the tear glands and the salivary glands, and those without ducts, like the thyroid gland. The ductless glands are particularly of interest in the study of personality, so a description of them has been postponed until Chapter XXII.

Levels of Nervous Function. One striking thing about the brain is its system of levels, one superimposed upon the other. This is not a surprising arrangement when one remembers that the human brain has undergone a long process of development. Our brains possess nervous centers that remind one very clearly of the nervous systems of earthworm, frog, and chimpanzee. Nature is always conservative. As new and better brains were invented, each being added to the old, the old brains were not discarded. They were preserved and made to continue to do service under the management of the new. There have been a number of apparent additions to the human brain, but for our purposes, it will suffice to mention only three main levels, corresponding roughly to three main levels of mental activity or adjustment. These levels may be labeled as follows: (1) Reflex level, with nervous centers in the spinal cord and the brain stem, which is merely an extension of the spinal cord into the lower part of the brain; (2) the "old-brain" level, with nervous centers

below the cerebrum; and (3) the "new-brain" or cortical level. These levels will be discussed in turn.

The Reflex Level. A reflex adjustment is a relatively simple, prompt, and dependable reaction to a relatively simple and local stimulus. An object approaches your eye quickly and you blink; a sharp, loud sound occurs and you give a startled jump. An irritation inside your nose brings a sneeze; an irritation in the windpipe brings a cough. A hammer blow just below your knee cap brings forth a kick of the leg, a response that we call the *patellar reflex*. Other common reflexes are hiccoughing, yawning, vomiting, swallowing, sobbing, smiling, wincing, and the like. Most glandular responses are reflexive in character, for example, salivation, perspiring, and shedding tears.

While a reflex is a most dependable response, it is by no means an isolated and constant unit. Knowing that the appropriate stimulus for a reflex response is presented, one can fully expect the response to come. But it may actually fail to come, or it may come to various degrees even though the stimulus is the same. Neither is a reflex to be expected in every individual under the same external conditions. For example, among 217 individuals tested for the patellar reflex, eleven of them, or about 5 per cent, lacked the reflex entirely at the time of the test.[3] Many internal conditions may alter or modify the same reflex: fatigue, relaxation, tension, problem solving, distraction, and a few others.

The Levels are Interdependent. The point is that any reflex activity is influenced somewhat by what is going on elsewhere in the nervous system. No reflex occurs in complete isolation. All parts of the nervous system are interdependent. Furthermore, the interplay among the higher levels is so complete that anything like a simple reflex at those levels is all but lost in the utter complexity of things.

The "Old-Brain" Level. The parts of the brain included in this main level are best seen in Fig. 3.2. Notice that in Fig. 3.2. we have a section of the human head as if cut exactly through

the middle. We are therefore looking at the right half of the brain from the inside. Almost everything to be seen here has its exact duplicate in the left half. The brain, like most of the body, is bilaterally symmetrical. Included in the old brain are the cerebellum (C), thalamus (T), hypothalamus (H), and striatum (S). Each is an important nervous center with fairly well-known functions.

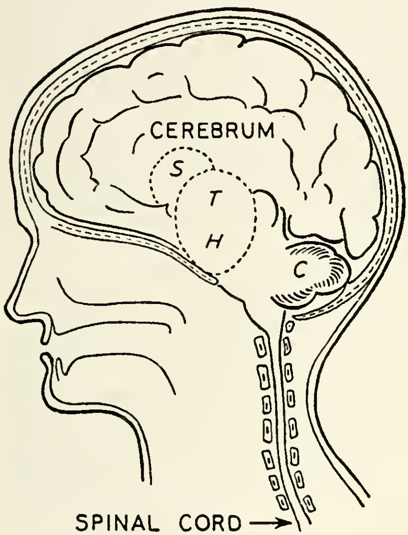

FIGURE 3.2. Diagram of the human brain showing the three general levels of adjustment mechanisms. This view is a longitudinal section through the middle of the head, showing the location of the cerebellum (C), thalamus (T), hypothalamus (H), and straitum (S).

The Thalamus. At the heart of the old brain is the thalamus. This is the chief receiver of incoming impulses. It serves as a relay station, sending on to the cerebrum afferent impulses that it receives. The thalamus is also a receiving agent for the hypothalamus and for the striatum.

The Striatum and the Cerebellum. The striatum is the chief *coordinator* for outgoing messages. It takes care of the routine work of organizing some patterns of movement that are called for. The cerebellum is the chief *power house* for outgoing impulses. It amplifies and energizes motor impulses that were started out from the cerebrum or from the striatum. Working hand in hand, the striatum and the cerebrum determine *which* muscles are to be activated in combination and the cerebellum determines *how much*.

The Hypothalamus. This is the chief brain center for internal bodily reactions. It has many delicate regulations to make in order to keep the vital processes of the body functioning in a balanced manner. It keeps in close touch with the general condition of the body, its temperature, its blood chemistry, and its various needs.

The hypothalamus has a two-way communication with the cerebrum. Thus, the cerebrum can interpret external situations as being dangerous or harmless, determining whether or not the hypothalamus should be excited. The hypothalamus can also report back to the cerebrum concerning its own activities, sending its impulses upward over other sets of fibers.

The Cerebral Cortex. The most significant part of the cerebrum is its outer covering of gray matter known as the *cerebral cortex*. Only a few millimeters thick, if its many deep wrinkles were ironed out, this layer of gray matter would cover an area of several square feet.

It is estimated that the average human cortex alone contains about 12,000,000,000 neurones. Under the microscope it will be seen that these neurones are very richly supplied with branches. The possibilities for the interconnections among these 12 billion cells, and between the cortex and other levels, are unthinkable. A study of the cortex shows that each part is well connected with other parts by means of *association fibers*. It is connected with lower centers in a two-way communication. The two hemispheres, right and left, are well connected with one another.

All in all, the cerebral cortex would seem to be in a position to become master of the situation. And yet, like an efficient master, it turns the more routine operations over to lower centers, so long as they can manage those operations satisfactorily. In fact, many of the lower nervous activities are entirely beyond voluntary control. One could not intentionally control his own blood pressure, stop his heart, or prevent breathing for more than a short time.

Localization of Functions in the Cortex. A century of intensive study of the cortex has revealed many facts about what its parts have to do with mental activity. Roughly speaking, we can map out the cortex into sensory, motor, and association areas. The sensory areas receive impulses from incoming (afferent) fibers. The motor areas are points of departure of impulses that are going to end in muscles or glands. The association areas, which occupy about three-fourths of the entire cortex, appear to have no other function than to connect other parts, thus to

support and correlate the actions of the sensory and motor areas. The locations of sensory and motor areas are shown in Fig. 3.3.

The Sensory Centers of the Cortex. First, let it be said that the sensations that we experience do not take place in these areas. Sensations, as observed introspectively, occur *where we experience them.* Lights and colors occur before our eyes; sounds in the space surrounding us; felt sensations occur within or on our bodies. How some electrochemical actions in our brains generate colors or sounds outside our brains is still a deep mystery.

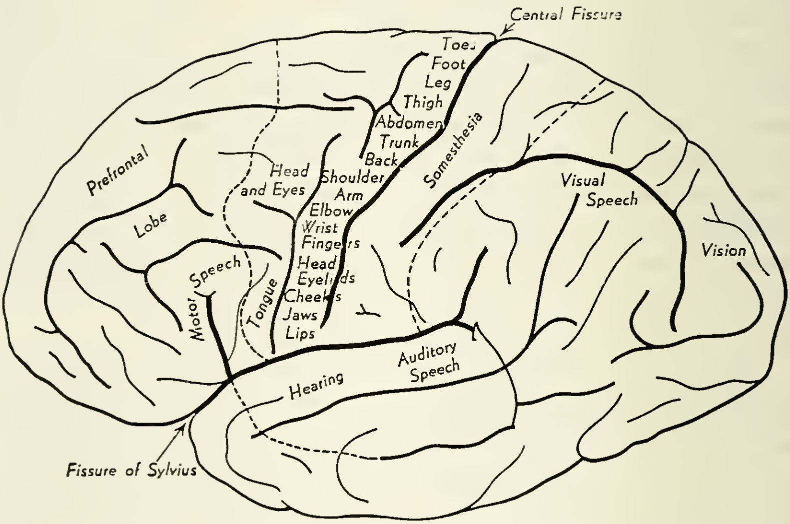

FIGURE 3.3 The human cerebrum, showing the left hemisphere with locations of cerebral functions. This entire view is duplicated in the right hemisphere. (From C. J. Herrick, *Introduction to Neurology*, W. B. Saunders Company.)

But it should be as reasonable a phenomenon as the way in which sun spots generate magnetic disturbances on the earth, or as natural a process as a broadcasting station generating music in your home.

(1) *The Visual Center.* The brain in Fig. 3.3 shows only the outside of the left hemisphere. The cortex extends over on the side between the two hemispheres. The visual center is at the very tip of the rear end of the brain. The visual cortex corresponds point for point with the retina of the eye so that,

when a certain pattern of light stimulates the retina, and a certain pattern of nerve impulses consequently leaves the retina over the optic nerve, there will arrive at the visual cortex a faithful duplicate of that pattern.[4] The only difference is that, whereas the retina is a smoothly curved surface—it has to be smooth in order to receive the physical image projected upon it—the visual cortex, by comparison, is badly distorted in its many folds. But this apparently makes no difference. Orderly arrangement of the visual picture-to-be is the important thing.

Besides seeing mere light and color, we also see pattern or form, and we interpret the pattern to mean something. It is thought that this further elaboration of what we see depends more upon the cortex neighboring upon the visual center, but farther forward in the occipital lobe. Higher elaborations, such as thinking about the visual pattern, would bring in more of distant parts of the cortex.

(2) *The Auditory Center.* The primary auditory center is located just below the Fissure of Sylvius, and its secondary area is located in the immediate neighborhood. The primary area is said to generate sounds, as such, while the secondary area gives elaboration and meaning to them. The understanding of spoken speech is said to depend more upon a neighboring area a little more removed from the primary center.

(3) *The Somesthetic Center.* The fold of cortex lying just behind the central fissure is the center for bodily sensations, or the *somesthetic area* (see Fig. 3.3). There is strong evidence that there is a close correspondence between points in this area and points in the entire body.[5] Just as the visual cortex duplicates the retina, this region of the cortex duplicates the layout of receptors covering the entire body. Presumably, the cortex to the rear of this somesthetic area contains the structures for elaborating upon what we feel, but there is no good evidence available for this.

(4) *Centers for Smell and Taste.* The centers for smell and taste sensations are less definitely known, but they are probably located on the cortex lying between the two hemispheres and near their base. It must be remembered that the one hemis-

phere is a mirror reflection of the other; each has its own visual, auditory, and somesthetic areas, as well as those for smell and taste.

The Motor Centers. The fold of cortex lying just in front of the central fissure is known as the *primary motor center.* Stimulation of this area with electric currents results in muscular contractions that are rather specific and local. For example, one point when stimulated may lead to opening the lower jaw and that is all. The orderly arrangement of the muscles activated from points in the motor area is apparent from Fig. 3.3. Points at the top of the fold control the feet and lower extremities. Points at the lower end control movements about the head, with points in between the ends controlling one's middle.

Just in front of the primary motor area, the cortex has to do with coordinations of movements into finer and more complex adjustments. The two hemispheres have these motor centers, duplicated, but the left hemisphere controls the right side of the body and the right hemisphere controls the left side, contrary to what you might expect.

The Frontal Lobes. Our interest, next, is in the parts to the front of the motor areas, a region known as the *prefrontal* lobes. In the popular mind, these lobes are believed to be the seat of intelligence or of thinking. To the uninformed a high forehead means a large frontal lobe and great intelligence.

The real function of these lobes has been the hardest of all to determine. The best evidence we have is gleaned from human beings whose frontal lobes were destroyed by accident or by a necessary operation. There have also been some systematic experiments in which parts of frontal lobes of apes and monkeys have been removed. In more recent years, some surgeons have cut the connections between frontal lobes and the hypothalamus in an attempt to relieve nervous and mental symptoms.

The removal of only one prefrontal lobe may have no noticeable effect. When both are removed there are certain damaging results: an impaired memory ability; a lack of spontaneous activity or initiative; a loss of active attention or concentration;

and a loss of power to plan. There may be some loss in every phase of mental activity, but not always.[6]

Handedness and the Speech Center. It was said before that each motor center in its own hemisphere controls only one side of the body. The consequences of this fact are sometimes interesting and sometimes distressing. All would be well, except that some organs of response are on the middle line of the body. Among these are the organs of speech—the tongue, and the larynx. One-half of each is controlled by the motor center in one hemisphere. Yet the tongue and the larynx, to act efficiently, must move as single organs. In the average individual, the problem is solved by the fact that one hemisphere is dominant and takes the lead in the management of speech. In the right-handed person the dominant hemisphere is the left one. This hemisphere is then said to contain the center for speech. The two hemispheres being connected, the nondominant motor center accepts the lead of the dominant one, and activates its side of the speech organs in step with the dominant one.

But suppose that there should be any doubt as to which hemisphere is the dominant one, and that there is uncertainty, if not open conflict, between them? The result may be stuttering, stammering, or some other form of speech defect. Dominance, when naturally established, is coupled with hand preference. In right-handed individuals the left hemisphere is dominant and contains the leading center for speech; in left-handed individuals it is the right hemisphere that is dominant.

It is now fairly well established that hand preference is hereditary and that it makes its first definite appearance in the average child between the ninth and eleventh months of age. It is probably inherited to varying degrees, with some individuals having no distinct preference at all. Something like 80 per cent are natively inclined in different degrees toward right-handedness. But in our right-handed civilization, right-handed habits are enforced upon all but 4 per cent who remain with left-handed habits.[7] The 16 per cent who change over from left-preference to right-preference are trained with varying degrees of success and with varying degrees of risk of speech disorders.

Something like half of the stutterers are found to have made a change in hand preference.[8] Why some individuals can change with no resulting damage to speech while others cannot do so is not known. It should be added that a shift of handedness is only one of many causes of speech disorders.

Brain Waves. A nerve impulse has been described as a succession of electrochemical discharges sweeping along a nerve fiber. Does the same kind of impulse occur in the brain? It has now been found possible to detect and to register similar electrical phenomena from the brain by attaching wires to the outside of the skull. By magnifying the power of these phenomena about a million times the electrical changes can be registered in readable form, as may be seen in Fig. 3.4. The typical brain

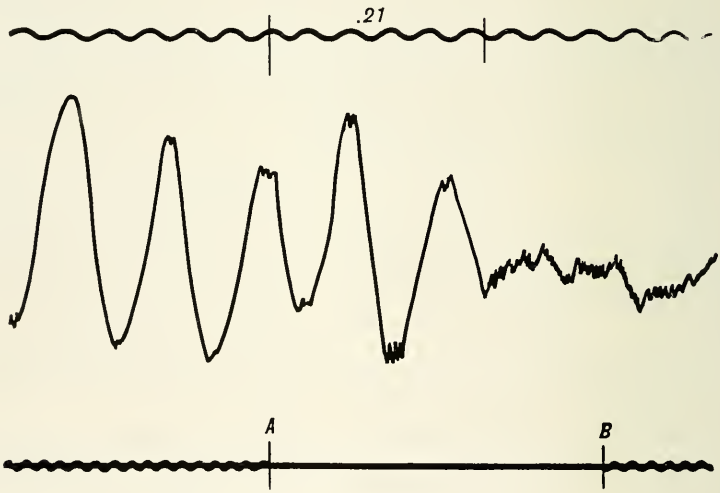

FIGURE 3.4 A recorded brain wave. The wavy line at the top is a time record in units of 1/25 second. The bottom line shows when the stimulus was applied, beginning at A and ending at B. The *alpha* wave is the one of large amplitude and long phase at the first part of the record. It was broken up .21 second after the stimulus was applied. (Courtesy of L. E. Travis.)

wave with about ten major discharges per second is known as the *alpha wave.* It is best obtained in the region of the visual center when the individual is reposing on a couch with eyes closed, and is generally inactive, but awake. When the individual opens his eyes to look at a stimulus, the waves become irregular

and decrease in amplitude, but there may be a noticeable rhythm remaining, with a frequncy much higher than ten.

The most important idea for psychology in the discovery of brain waves is that the brain is perpetually active. What stimulation does is not merely to stir up activity, but to alter the activity that is already present. The brain-wave record, or *encephalogram,* is now used to aid in the diagnosis of certain brain disorders, such as epilepsy.

Cooperation of the Levels. While the various levels and parts of the nervous system were described separately, it must not be supposed that they function alone, or that one stimulus excites one level and another excites a different level. As a general rule any stimulus makes itself felt to some extent at all levels, and the adjustment to that stimulus may be the outcome of simultaneous activity at all levels.

As another general rule, the lower centers make a more prompt and unhesitating adjustment when allowed to do so by the lack of interference from higher centers. When the brain and brain stem of an animal are removed from connection with the spinal cord by cutting the cord at the level of the neck, the spinal reflexes are usually more prompt and vigorous. This means that the inhibition of higher centers has been removed. It is the nature of the higher centers to "deliberate" longer over any stimulus. The cerebral cortex, being in more complete touch with the entire situation, both outside and inside the body, is most inclined to take into consideration every element of the situation before releasing a response, either directly from its own motor center, or from lower centers. The cortex, particularly by virtue of its speech centers, is the center of self-control, as we shall see in later chapters.

Development of Behavior

The birth, growth, decline, and death of an individual have always been interesting subjects to most human beings. Psychology has devoted a great deal of its efforts to the study of human growth and development. For if we are to understand the more complex behavior of youths and adults, we

must give attention to its beginnings in the infant and child. Behavior in the infant and child is simpler, and the principles that "explain" behavior in its simpler froms should also apply to its more complex forms. It is also true that with respect to behavior, "the child is father to the man." If we find out what influences the actions of the infant and child we may well be able to manipulate them to father the kind of adult we want.

Life Begins. It is now common knowledge that the individual begins life at the moment of conception, when a sperm from the father merges with an egg from the mother. The most significant step in this is the union of the nucleus of the sperm with the nucleus of the egg. These nuclei are the carriers of the 48 chromosomes, half from the father and half from the mother, that are to determine the heredity of the new individual. Under a very high-powered microscope, a chromosome looks like a crumpled narrow ribbon with alternating dark and light cross bands. Each chromosome contains a number of genes, which are the essential determiners of heredity. The new individual has a unique combination of genes; a combination the like of which was never known before, except under the rarest of coincidences.

One might say that the chromosomes contain the "blueprints" for building a particular individual. How these "blueprints" get translated into a complete individual with human form is still a mystery. One theory is that the nucleus, with its particular gene pattern, creates an electrodynamic field, within which the dividing cells are regulated. Each new cell contains the same pattern of genes and would presumably cooperate with other cells in maintaining the same electrodynamic field. Although we actually do not know how it is done, the genes somehow control the way in which the individual grows.

The fertilized egg very soon attaches itself to the inside of the mother's uterus where it absorbs nourishment and oxygen from the mother's blood and returns to her blood its waste products. It leads a parasitical life until the time of birth. It is well protected from all external environmental changes. It need exert no effort. All it needs to do is to grow, which it does with remarkable speed. Within two or three months it takes on essentially

human form. Its parasitical existence continues normally for 280 days after conception. The period of gestation has been known to vary from 215 to 334 days, however.

Fetal Behavior. Long before birth, behavior of various kinds occurs, both in the embryo (first ten weeks) and in the fetus (last 30 weeks). This is known by virtue of observations made on those prematurely born or those removed from the mother by operations for reasons of therapy.

The first muscular contraction is that of heart muscle, or of tissue that is to become heart muscle, at about the third week. This is hardly behavior in the ordinary sense, since it is not a response to stimulation of receptors. Observers have applied stimuli, especially in the form of contact with the skin at various places, to see what would happen. Some of the typical findings will now be described.

The first body region to become sensitive is the face, especially near the mouth and nose. Stimulation there at about 8 to 9 weeks of menstrual age * arouses what is evidently a withdrawal response involving a general attempt to turn away from the stimulus. This may involve movements down as far as the rump and the thighs. The response is very mechanical and stereotyped.

At 10-11 weeks, stimulation of the palm of the hand gives rise to a flexion of the fingers. Stimulation on the sole of the foot, however, brings no response. During the next two weeks more areas become sensitive and additional patterns of response come into the picture. There is some increasing localization of responses, in the sense that stimulation at a point brings less widespread movements. In other words, local reflexes begin to appear. By weeks 13-14, many reflexes have appeared, including the Babinski reflex. The latter is a fanning out of the toes (especially the big toe) in response to a stroking of the sole of the foot. By the 25th week the fetus also has the patterns of breathing, crying, and sucking, although the reactions are weak and need much further development before they would function well.

In the uterus, of course, very little stimulation is normally applied to the fetus. After the fourth month, however, there is

* Menstrual age is measured from the beginning of the last menstrual period before conception. It is 10 to 15 days longer than actual age.

much spontaneous activity, involving twistings of the head and trunk and extensions and flexations of arms and legs. The mother feels this as a "quickening." These movements give opportunity for the exercising of muscles, which probably grow stronger with exercise as they do after birth.

The Neonate. The newborn child during the first month of life outside his mother's uterus is called a *neonate.* He is much more accessible to scientific study, and much advantage has been taken of that fact. His equipment for behavior and his behavior itself have been thoroughly explored and partially mapped by investigators.

Sensory Functions of the Neonate. The neonate does not have the full use of his senses. His eyes respond to changes in light, for he shows most of the common visual reflexes. Some studies seem to show that he can discriminate colors but others do not. His eye muscles are too weak and lacking in coordination to allow his two eyes to work together. Consequently, he cannot have good visual space perception (see Ch. X).

Although his middle ear is filled with a fluid at the time of birth and for a short time after, he can probably hear sounds. He does not have much discrimination among sounds of different pitch or of different complexity. In other words, he is probably not deaf, but he does not hear very accurately.

Through his sense of smell, he shows reactions of acceptance or rejection, as if he found some odors pleasant and others unpleasant. The same applies to things tasted, for he shows different facial expressions, irregular breathing, and seeking or rejecting movements as signs of discrimination.

His body is generally sensitive to contact stimuli which he crudely localizes, as shown by scratching movements and other local reactions. He does not seem very responsive to painful stimuli, but this has not been explored very much for obvious reasons. He shows definite reactions to body postures. For example, when held head downward, suspended from his feet, he arches his back and pulls his head back. When supported under his arms with feet touching the floor, he makes something like

stepping movements. When a rod touches the palm of his hand, his fingers flex over it in a "clinging" reflex. When strong enough he may bear his own weight thus suspended.

Response Patterns. Certain response patterns are fairly well developed at birth. Many are merely further developments of patterns achieved in development before birth. All continue to improve with time after birth.

The neonate's feeding pattern is almost universally ready to function. When he is hungry, touch his cheek lightly with a nipple. His head will turn so as to bring his lips in touch with the nipple. He seeks to grasp the nipple, and having grasped it his sucking reflexes begin, followed by swallowing reflexes. His breathing adapts itself to this pattern. Following the feeding period, his fingers go to his mouth and sucking may continue for a time. There seems to be something compulsive about the act of sucking itself, apart from its use in taking nourishment.

The neonate's muscles generally are so weak that he cannot sit without support or even hold his head erect. He can turn his head when it is given some support. He shows signs of defending himself against obnoxious stimuli by withdrawal or rejection reactions or by efforts to remove them. In addition to the reflexes normally present before birth, there is an interesting response to sudden, strong stimuli. This is known as the *Moro reflex*. It consists of a thrust-like extension of the limbs, following which they are brought around toward the front. By the age of four months the same kind of stimuli usually give rise to a somewhat different *startle-pattern* response that is found even in adults. This is described in Chapter VII.

The crying reaction that is ready to function at birth becomes somewhat varied, depending upon the source of the need for crying. It thus rapidly becomes a means of communication and has a social value. The mother or nurse is not only sensitive to the infant's cries but learns to distinguish between the hunger cry, the fatigue cry, and other cries. Facial expressions, in addition to that in crying, also soon appear. These are also among the infant's first social reactions.

Developmental Norms. The growth of behavior in an infant is generally so regular, and its sequences so predictable, that it is possible to lay down some general behavior norms. The incidence of each response pattern and of the power to do various types of things are characteristic of certain age levels. It is therefore possible to make a chart of development for the "normal" or average child. Although not all individuals develop at the same rate in every respect, we do not expect an infant to deviate very far from the norms.

The Main Aspects of Development. It is customary to distinguish development along four main lines:

(1) motor, including posture, locomotion, use of hands, etc.;
(2) adaptive, including perceptual activities, orientation, alertness, construction, exploitation of objects, etc.;
(3) language, including comprehension, expression, and communication, etc.; and
(4) personal-social, including reactions to other persons, to culture, property, and conventions.

A child may develop at somewhat different rates in these four directions. Evidence of motor development, and to some extent of perceptual (sensory) development, has been obtained in the fetus and in the neonate, as we have just seen. Evidences of most of the adaptive, language, and personal-social development cannot be found until a number of months after birth. What we call intelligence is most strongly related to language development, which cannot be very accurately assessed until about the age of two. Prospective foster parents who want evidence of intelligence level of a prospective foster child cannot depend very much upon present test results obtained during the first two years.

Some Typical Indices of Infant Development. A great many tests of psychological status of the infant have been devised and their age norms have been fairly well established. The following list will illustrate the kind of behavior that can usually be achieved at the various age levels during the first three years: [9]

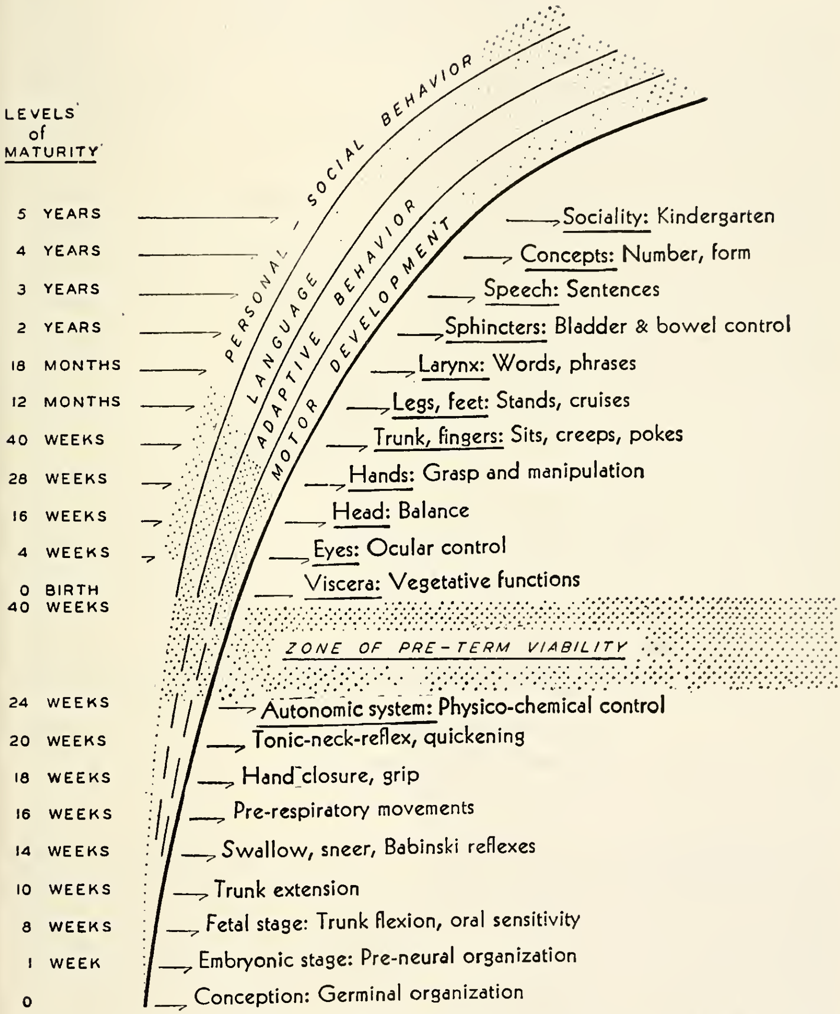

FIGURE 3.5 A diagram showing various aspects of development of behavior in the human fetus, infant, and child. (From A. Gesell and C. S. Amatruda, *Developmental Diagnosis: Normal and Abnormal Child Development,* courtesy of Paul B. Hoeber, Inc.)

Month	*Behavior*
1	Prolonged looking at a ring
2	Eyes follow a moving pencil
3	Aware of a strange situation
3	Carries ring to mouth
4	Inspects hand
4	Turns toward a sound
5	Picks up a cube
6	Approaches image in mirror
7	Smiles at image
8	Cooperates in simple games
9	Shows interest in objects
10	Attempts to imitate scribble
11	Holds a crayon adaptively
12	Holds a cup to drink
14	Builds a "tower" of two cubes
16	Throws a ball
18	Imitates pencil stroke
20	Turns a doorknob
22	Names three objects
24	Names five pictures
25	Builds a tower of eight cubes
28	Understands three prepositions
30	Buttons one button
34	Knows five prepositions
35	Copies one circle

Development of Prehension. The list just presented gives only a general idea of what can be done by the infant at different months of age after birth. A study of any one of the activities mentioned will show that no accomplishment emerges suddenly and completely. Development comes by stages. A number of activities have been studied by psychologists with systematic observations, sometimes with motion-picture records that are studied frame by frame. One of those activities is prehension—the grasping of an object with the thumb and fingers.

If you were to see a one-inch cube lying on the table before you and if you wanted to pick it up, the act would be quite simple for you. Your preferred arm would move accurately, bringing

your hand into position. With thumb and forefinger on opposite sides, by a pincer movement you would grasp the cube and then retract your arm. It takes an infant almost a year after birth to achieve this method of picking up a cube.

Before the age of 28 weeks, few infants succeed even in making substantial contact with the cube. Before that age, the infant is likely merely to make arm movements sweeping back and forth in the general direction of the cube, having some difficulty in touching it. Between the 28th and 36th weeks the typical method is to make a sort of circuitous movement of the hand as if attempting to get around behind the cube to rake it in. The infant may get the cube into contact with his palm, but there is little effective grasping. After 36 weeks the arm movement is more directly toward its goal. The wrist, which was held straight at 24 weeks tends more and more to flex in making contact with the cube. By 20 weeks the finger-grasping movement enters the picture. The opposition of thumb and fingers in grasping is not typical until the 32nd week. Even after adult methods have been achieved there is much room for improvement in accuracy and in speed. While at 20 weeks the cube is often knocked out of place, at 52 weeks it is moved very little. At 20 weeks the average time needed for grasping is several times as great as at 52 weeks. The average adult will of course do much better in both accuracy and speed than the one-year-old.

Development of Social Behavior. The growth of social behavior is much less regular than that of motor behavior. The inducements and opportunities in this respect differ a great deal from one child to another. Given the same inducements and opportunities, however, children will show certain trends in terms of expanding social participation.

A nursery school is a favorable place for making observations of this type of behavior. For many children this is the first important step toward learning to get along with others outside the home. When a group of children, who are usually from two to four-and-a-half years of age, are playing at a sandpile, we may find several types of play. These represent several degrees of social participation. In the extreme case, very rarely observed, the child is doing nothing. A few may be engaged in solitary

play, ignoring others. Some engage in parallel play. That is, they do what others are doing but they do it alone. Still others engage in some activity with each other in an unorganized and incidental manner. A more socialized play is cooperative play, in which there is some common goal and some degree of leadership.

In the nursery-school group, the older the child the more he tends to engage in the higher levels of social participation and the less he is inclined to the solitary types of play. It does not make so very much difference how long he has attended the nursery school. His degree of participation depends much more on his age.[10] The same conclusion can be drawn concerning his exhibition of leadership, when "leadership" in this situation is shown in the form of "bossing" other children or otherwise determining their actions.

Development of Other Types of Behavior. There is insufficient space to mention here development in other areas of behavior. Later chapters will touch upon this subject from time to time. Especially to be noted will be the development of intelligence, and of personality traits in general, in the last two chapters. At other places will be mentioned development of powers of perception, memory, reasoning, and creative abilities.

Principles of Development. From the multitude of observations that have been made of fetal and infant behavior it is possible to draw conclusions concerning some general principles of development. These principles have most obvious application to motor behavior but they have more general application.

Differentiation. More specific and localized patterns of movement emerge out of crude, gross movements. The description of development of prehension illustrates this principle. In the first attempts, the muscular contractions involved may be rather widespread. At least they are not confined to the necessary ones. The arm moves as a whole, thumb and fingers going together as the infant paws at the cube or merely palms it. If fingers flex to seize the cube, they all flex together. The pincer action that is to come differentiates out from this mass movement.

The growth of a precise and well-organized pattern of muscular contractions is analogous to the progress of a sculptor on

a piece of sculpture. The sculptor begins with a block of stone of merely the general size and shape needed. He first cuts away large chunks of stone and general contours take shape. With finer and finer modifications and refinements, the final, precise form is approached.

Amalgamation. Not all development can be included under the heading of differentiation. There is another type of change that is almost opposite to differentiation in some respects. It will be recalled that even in the fetus certain localized, rather mechanical reflexes appear. Among the reflexes noted soon after birth are the alternate stepping movements that may be seen when the infant lies on his back or when he is supported with feet touching the floor. He shows, quite independently from these stepping movements, an extensor thrust of the legs, a reflex that he needs in standing erect. Standing erect also requires the combination of other reflexes involving posture of the trunk and head. A complete walking pattern involves the proper organization of all these part movements into the right combinations. With practice they become welded into a combination and sequence of well-timed muscular contractions the total pattern involving the whole body.

Reflexes seem to appear rather spontaneously. Some seem to be quite ready for amalgamation into useful larger patterns as if that were their reason for existing. Others, however, remain rather isolated and do little in cooperation with others—the eye blink, for example. It can also be said that reflexes are by no means the only materials for the organization of new patterns. Some of the component parts of patterns have previously come about by the process of differentiation. As a matter of fact, motor patterns often undergo modifications and reorganizations in which both differentiation and amalgamation occur.

Individuality. In spite of the regularities in development and the conformity to norms, there are many ways in which individuals differ. Each child is unique and his growth shows a distinctive pattern that is his own. Only identical twins have closely similar sequences of changes. Sometimes two children of this kind behave so much alike in the same situation or at the same

date it is almost uncanny. When children who are not identical twins are observed with respect to certain tendencies, however, it is often obvious that they differ in personality and their differences are sometimes quite persistent. Tendencies in which there is much personal consistency include: smiling, crying, energy output, social responsiveness, communicativeness, family attachment, and sense of humor. It is such differences that lead us to speak of individual personalities.

Maturation and Learning. Two major methods of development are distinguished—*maturation* and *learning*. Maturation is primarily a matter of the unfolding of the individual along the lines laid down in his genes that he inherits from his ancestors. It would be futile to maintain, of course, that the genes alone would make a complete individual. It is true that the embryo and fetus are remarkably exempted from being affected by unusual conditions of the mother. Their physical environments are very uniform from time to time and from individual to individual. It would seem, therefore, that the genes would determine almost entirely the development before birth. Yet, without the favorable temperature and chemical conditions that are almost always present, a normal organism could not grow. Unusual conditions are sometimes responsible for monsters and for defects such as harelip.

Learning, broadly defined, is a change in behavior that is due to behavior itself. After the child is born, stimuli force him to react, and the fact that he has reacted leaves him somewhat different from what he was before. The change is learning; a form of development. This is not to say that the change is necessarily in a desirable direction, either from the point of view of the child or of others who are concerned. Learning does not always mean improvement. It ordinarily makes the child more capable than he was before, however.

After birth the effects of maturation and learning are so intermingled that it is difficult to tell which has more to do with new behavior. Take walking, for example. We say that a child "learns to walk," as if it were entirely a matter of improvement with practice. Certainly, no child suddenly begins walking on his two legs. He goes through a sequence much like that illustrated

in Fig. 3.6. On the other hand, he cannot be "forced," like a hothouse plant, to learn to walk before he is ready, which is about the age of 13 months. This is a rather universal fact, applying to all races. The longer we might delay attempts at walking in a child during his second year, the more quickly he would master the art of walking after he does start. If he were delayed too long, and particularly if he had developed another mode of locomotion in the meantime, there would probably be some difficulty in learning to walk. This all means that there appear to be times in a child's life when he is "ripe" for most efficient learning of certain things. At those times learning will be easiest for him.

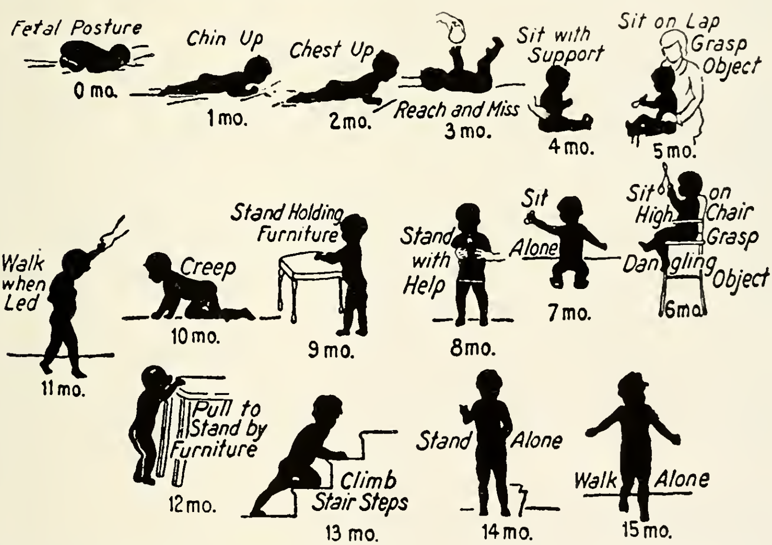

FIGURE 3.6 Illustration of motor development in the infant. The sequence was typical of 25 children who were studied intensively by Shirley, though the age at which new development came varied somewhat with the child. (Adapted from Mary Shirley, *The First Two Years*, University of Minnesota Press.)

An Experiment by the Method of Co-twin Control. Because identical twins arise from the same fertilized egg and hence have exactly the same genes, they should therefore have the same pattern of maturation. We can take advantage of this situation to perform some experiments on the relative contributions of maturation and learning to any particular behavior pattern. We can give the one twin special training in the pattern and not the other,

Whatever difference they show when tested later can be attributed to the effects of learning. If they have developed equally, we know that maturation was entirely responsible. Many such experiments have been performed, particularly by Gesell at the Yale Child Development Laboratory. A typical instance will be described.[11]

At the age of 46 weeks, twin T (the trained one) began practice in climbing a four-step stair leading to her crib or to her toys. She practiced ten minutes every morning, six days a week, for six weeks. Her co-twin, C (the "control" twin) was not permitted this kind of activity. At 52 weeks, the end of T's training period, C was tested in her ability to climb the same stairs and was given training like T had had for the next two weeks.

The essential results, comparing T and C, were as follows. On their very first trials (ten attempts), T climbed the stairs three times *with* help, while C climbed them seven times *without* help. The difference was due to six weeks of maturation. T reached a perfect score of 10 climbs in 10 attempts on her 25th day, while C reached that level on her 9th day. T scaled the stairs a total of 55 times during her first two weeks, while C scaled them 81 times during her (first) two weeks.

The most obvious conclusion would be that while neither twin would have climbed the stairs perfectly without practice, maturation had very much to do with preparing both to learn the act. It is not certain how much C's activity of other types during the six weeks had to do with her advantages in learning when she *did* start her practice. There is in learning a phenomenon known as "transfer of training" (see Ch. XV), which means that we actually learn one activity by practicing some other activity that bears some favorable relation to it.

Twins T and C were also subjected to unequal training in building towers and cubes and in acquiring vocabulary. At their 84th to 89th weeks T was given daily practice in acquiring new words. C was kept free from even hearing words. At the 89th week C began training similar to T's training. The result was that C did not learn as many words in four weeks as T had learned in five weeks, but at every day of her training period she led T in vocabulary score. By the 96th week all differences were gone.

Again, *rate* of learning seems to depend upon level of maturation. "Forcing" a child brings early returns but there is some doubt whether the effects are of permanent value.

Culture and Development. To what extent would a human child actually develop the human characteristics as we know them in our culture if left to the effects of maturation alone? We have the stories of Tarzan who, almost from the time of birth, grew up with the apes. How much of these stories is fact, how much is fiction?

The patterns of behavior that make a civilized human being are exceedingly complex. To what extent would they develop by maturation? In lower animals, we find some rather complicated unlearned or instinctive behavior patterns. The environments of many lower animals are so standardized that their needs can be met by the use of rather stereotyped behavior patterns. Man's environment, however, is so very complex and changing (largely due to his own doings) that it would be quite futile for him to pass along to new generations many fixed, routine behavior patterns. A human child, therefore, comes into the world without many stereotyped patterns of behavior but with a great capacity for learning and for adaptability to an enormous variety of situations. His maturation is of a rather general form, in terms of abilities to learn, rather than of specific patterns. The difference between man and the lower animals in this respect, however, is not absolute, as some examples will show.

Some Typical Instinctive Patterns. Unlearned patterns may be observed in their purest state among the insects such as the ants, bees, and wasps. Their daily routines, in fact their whole life spans, seem highly mechanized. And yet, closer observation shows many variations in their patterns of movements, and also some progressive changes that can be called learning. Birds build nests without previous experience or instruction, and the nest of each variety of birds is of its own peculiar construction. But here, also, one can see the effects of practice in the building of future nests. There is some profiting by experience.

The best sign that any behavior pattern is unlearned is to isolate the young from any opportunity of seeing or hearing older

individuals use it. Roller canaries, kept isolated in sound-proof cages from the time they are hatched, will, at the proper age, show all the elementary songs characteristic of that bird.[12] Other kinds of birds develop in a similar way without being trained in the song of their own species. But changes in their songs can be introduced if they are brought up in the presence of other species. A canary can even be taught to whistle a simple tune.

All this merely goes to show that rather flexible patterns of behavior have inherited mechanisms that can be modified to better suit the environment in which the individual lives. Even the most unvarying pattern is subject to some change. And even the most dependable pattern sometimes fails to appear in response to its natural stimulus. For example, the pattern for killing and eating rats and mice appears in some kittens without any training when they are old enough, but not in others even after their mothers have set an example for them.[13] This forces us to the conclusion that an instinctive pattern need not appear in every member of a species, that it is inherited in varying degree by different individuals, and that it sometimes needs some inducement (perhaps always) from the environment in order to bring it out.

Instances of Feral Man. Feral means "wild" or "untamed." A number of times children have been found abandoned to grow up apart from human kind. When they are discovered, they are more animal than human in their behavior. In India, for example, two children were found living in a den of wolves. They walked on all fours, made howls like wolves, "wolfed" their food, and had other reactions similar to wolves.[14] That is about as human as any children would become without the presence of other human beings as we know them. Such observations highlight the tremendous contribution of the child's cultural environment to his development.

Domestication of Animals. On the other hand, the contrast between tamed or domesticated animals and their relatives who develop without human influence is also striking. A pet dog behaves very differently from a wild dog. A plow horse responds differently from a member of a wild herd. And yet, there are

limits in humanizing lower animals. A few attempts have been made in the humanizing of chimpanzees, who are nearest to man in terms of structure. A chimpanzee can be adapted to wearing human clothing and to eating with human implements and with human table manners. Efforts to teach them to talk, however, have generally failed. This one thing has prevented any very general culturizing of the chimpanzee.

Children in Different Cultures. A few anthropological studies comparing children growing up in different cultures have been very illuminating. Dennis, for example, has observed the Hopi child's life, and Margaret Mead has made extensive studies of children in many other primitive cultures.[15,16] We all know that the adults who grow up in those cultures differ very much in their methods of doing things, in their social customs, their moral codes, and their attitudes and beliefs in general. To what extent are the more essentially human qualities affected? The answer to this question has important bearings upon the methods of child rearing. It also may account for some of the differences between races and national groups with respect to temperament, effort, belligerence, and economic well-being.

The Hopi child is permitted to eat and to sleep whenever he feels like it. He is rarely frustrated and he rarely cries. His weaning is delayed until during his second year, and his toilet training is not started until he can walk and can understand and speak a few words. What effect will such "liberal" training have upon his personality as compared with the more restricting and frustrating treatment experienced by most American children? The infant in Bali is intentionally frustrated by the mother who showingly lavishes affection upon another child in his presence. He is expected to learn to do nothing about his frustrations of this type.

We do not know all the answers to the questions posed by these observations. Until experimental controls can somehow be brought to bear on such situations we cannot be sure of direct outcomes. There are some things one would hesitate to do to a child, of course, in the way of an experiment. But within limits there are many possible laboratory situations that can be set up

for experimental purposes, and a number of such studies have been made on effects of different treatments upon the development of personality traits.

Heredity and Environment

We have already seen that in the development of each person's behavior both maturation and learning play their parts. We have also seen that maturation is largely determined by heredity, whereas learning is largely determined by one's environment. It is best to say "largely" in both cases because interaction of the two sources is usually necessary. It is desirable for us to take a closer look at the old and ever popular question: Which deserves more credit, on the whole, for making a person what he is, heredity or environment. In the context of psychology, the question is narrowed to the individual's personality—his abilities and other traits.

The problem is more than an academic one, for if we wish to improve the human race we must know the answer. If abilities and other traits of persons differ because of heredity, then to improve the race we should carefully select the parents of the generations to come. If personalities are made what they are under environmental pressures, then we can ignore the stock from which the next generations come and devote our efforts toward improving the milieu within which children develop, and the means of educating them. If some traits are more due to the one source and other traits more to the other source, as is likely to be the case, we can put the emphasis where it belongs in either case.

Some General Facts About Human Heredity. It has already been stated that each child derives 24 chromosomes from his father and 24 from his mother. With half of his genes from his father and half from his mother, one might expect him to resemble them equally. It is not as simple as that.

Some of the genes we call dominant and some recessive. For example, let us say that each person receives two genes for eye color, one from each parent. A gene determining brown eyes is dominant, while one determining blue eyes is recessive. If a child draws two determiners for brown, then of course his eyes will be brown. If he draws one "brown" gene and one "blue" gene, then

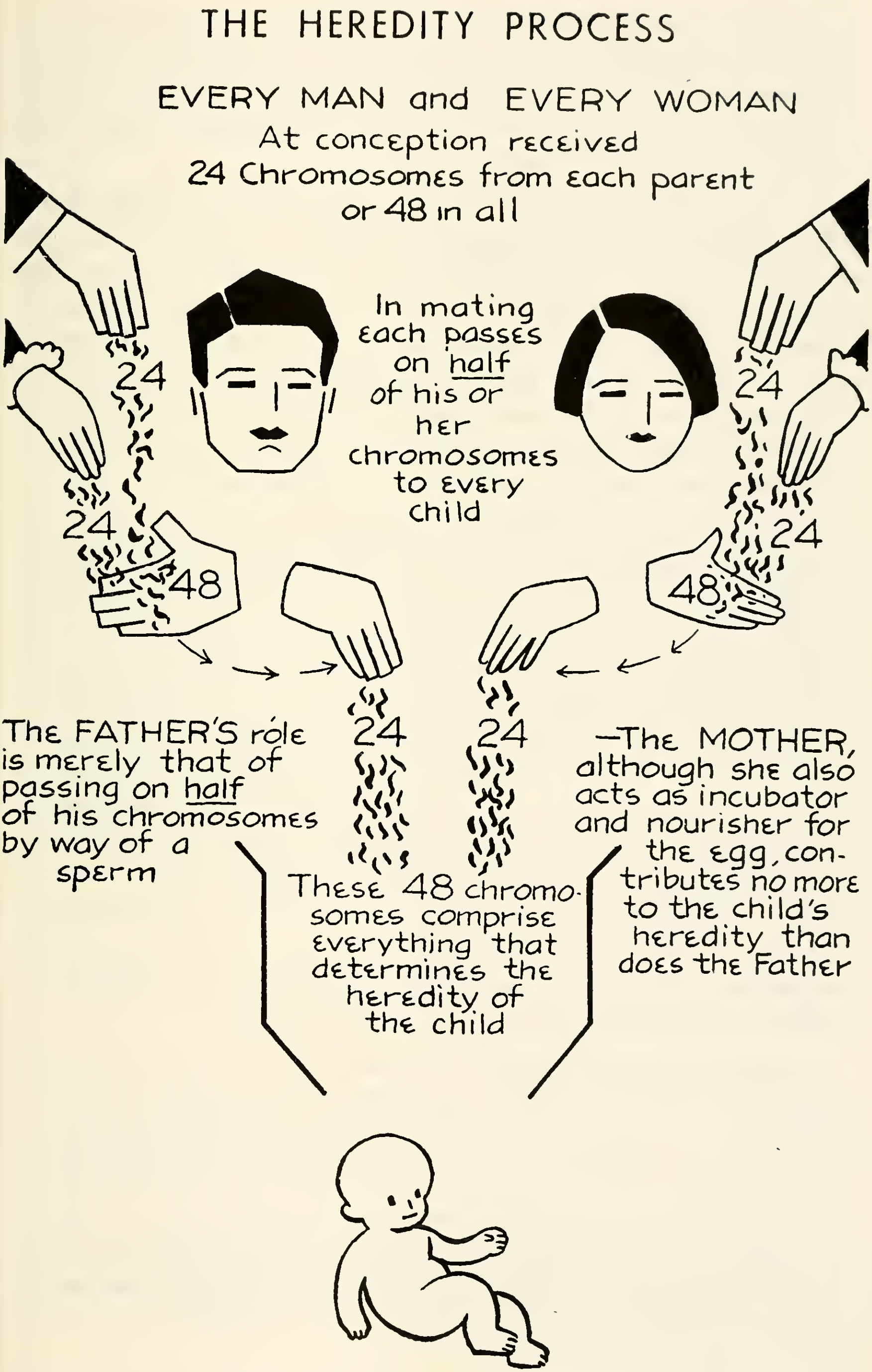

FIGURE 3.7 Diagram showing the transmission of chromosomes from parents to the child. (Adapted with permission from Amram Scheinfeld, *The New You and Heredity*, J. B. Lippincott Company.)

his eyes are just as brown; there is ordinarily no compromise or mixture of brown and blue. To have blue eyes the child has to draw two recessive blue genes. Which genes are drawn from each parent, and which come together in the offspring is thought to be very much a matter of chance.

How Children Resemble Their Parents. Thus it comes about that heredity does not necessarily make a child resemble his two parents. He may resemble one more than the other, depending upon from which one he draws more dominant genes. He may resemble neither; in fact in the very rare case, he could receive all recessive genes not apparent in either parent, but showing in grandparents or in more remote ancestors. In the long run, of course, children resemble their own parents more than they do other adults, but the resemblance is rarely complete.

Resemblance of Siblings. Brothers and sisters derive their hereditary determiners from the same original sets of genes, though, of course, they receive only half the genes that their parents possess. We speak of brothers and sisters by using the general term *siblings. Siblings* are children born to the same parents. Their similarity in genes may vary all the way from complete identity to complete difference, though these extremes are very rare. Children from different families also have some hereditary determiners in common, for there has been much crossbreeding of human stocks, especially within the same racial and national groups. It may happen occasionally that two children from different families chosen at random may have more hereditary determiners in common than do two siblings chosen at random. In the long run, however, we find greater similarities between siblings than between unrelated children.

Evidence from Family Resemblances. One approach to the problem of heredity versus environment, as determiners of mental abilities, has been to find the amount of correlation between parents and their children in mental-test scores.* The coefficients

* A *coefficient of correlation* is a number that tells us how much similarity or covariation there is between paired individuals in two groups (see Ch. XXI). The coefficient varies between 0.00, which means no agreement, and 1.00, which means perfect agreement. In Chapter XXI it will be seen that the coefficient of correlation is also used to indicate how well the *same* individuals agree with themselves in scores on two different tests.

of correlation have turned out generally in the neighborhood of +.50, though many are as low as +.35. This degree of correlation is what one would expect if abilities are determined by heredity, for it agrees with the correlation between parents and children in physical traits such as height and eye color. It has been assumed generally that such physical traits are almost completely determined by heredity. But the similarity of the correlations for abilities and physical traits need not necessarily mean that abilities are hereditary. Remember that children live with their parents, who, because of their level of intelligence, determine the kind of home and the educational advantages the child shall have.

Correlations between siblings in mental tests average slightly higher than between parent and child; usually in the neighborhood of +.60. Correlations between siblings in physical traits average +.52. The difference between these two has been taken to mean that similar environment in the family has increased the similarity in ability over and above that produced by similar heredity. Correlations between children selected at random and paired off as if they were siblings, are close to zero, as one should expect. But when unrelated children are paired according to level of home background, the coefficient is +.35. The difference between this and +.60 may be taken as an indicator of the influence of heredity in making siblings similar.

On the whole, the results from studying family resemblances do not yield a clear answer to our question. They suggest that both heredity and environment are important, and that is about all.

Evidence from the Study of Twins. Special interest in the study of heredity centers about twins as compared with other siblings. There are two kinds of twins, identical and fraternal.

Identical twins come from the same fertilized egg, which, instead of growing into one individual, becomes split into two. The nuclei of the two cells contain exactly the same hereditary determiners. Such twins resemble each other in almost complete detail, physically. They furnish fairly good experimental material, for some of them grow up together in the same home and school environments, whereas other pairs become separated, sometimes in widely

differing environments. If identical twins grow up differing in abilities and other personality traits, we know that environment is to blame for the differences.

Fraternal twins come from two separate fertilized eggs and the two individuals growing from them are like ordinary siblings, except that they are born together. Growing up together, their environmental opportunities are probably more uniform than those of ordinary siblings who differ in age. Will this kind of twins be more similar than ordinary siblings? We may justly raise the question, however, as to whether any two children in the same family ever have *exactly* equal opportunities for development. They obviously do not have *identical* environments. Twins have more equal environments, particularly identical twins, between whom there can hardly be much discrimination.

The Correlation between Twins. The similarity among abilities of twins as compared with siblings is shown in Table 3.1. The

TABLE 3.1.—CORRELATIONS BETWEEN TWINS VERSUS SIBLINGS IN MENTAL-TEST RATINGS

Type of Comparison	*Typical Correlations*
Ordinary siblings	.50–.60
Fraternal twins	.60–.70
Identical twins	.90–.95

correlations vary somewhat from one kind of test to another and from one group to another. The coefficients given here are typical. It is worth noting that fraternal twins, whose heredity is no more similar in the long run than that of ordinary siblings, perform more alike in mental tests. This difference can be credited to greater similarity of environment. But the difference between fraternals and identicals can be attributed almost entirely to heredity, since all twins have practically equal opportunities, except that the greater physical resemblance of identicals may bring them more impartial treatment. It is worth pointing out that the correlation between identicals reared together is about the same as we find in repeating the same test with the same group of children. In other words, identicals reared together resemble each other in test scores as closely as the same individual resembles himself.

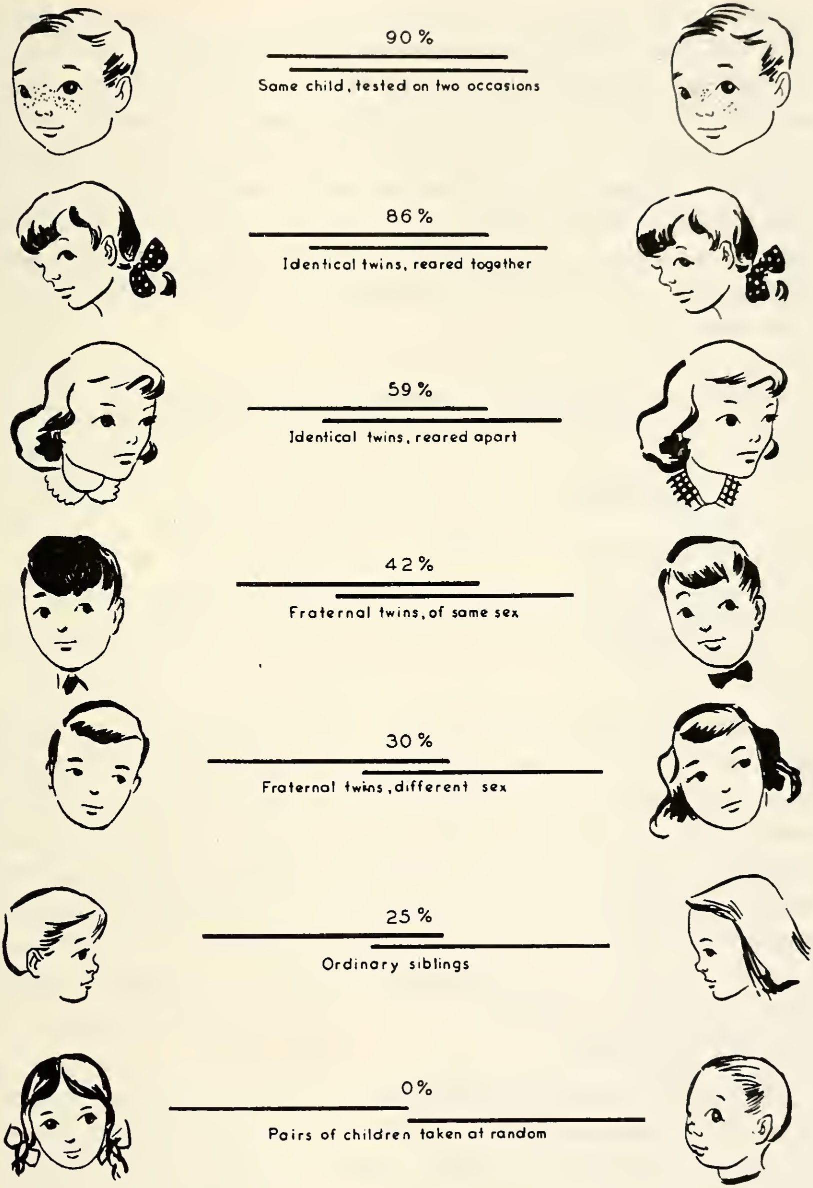

FIGURE 3.8 Diagram showing the extent of similarity of pairs of children with respect to intelligence as measured by the *IQ*, where similarity in heredity varies all the way from identical for pairs of identical twins to only chance similarity for pairs of unrelated children.

Differences Between Twins. Another way of comparing twins with ordinary siblings is to find the average differences in IQ's. Table 3.2 gives some typical results.* In this we see that the average difference in IQ obtained by taking pairs of unrelated children at random, is 15 points. The slight reduction to a difference of 13.1 for ordinary siblings seems rather small, unless we recall that heredity makes siblings different as well as similar. The greatest numerical change is that from ordinary siblings to fraternal twins, which we can credit to increased similarity in environment.

TABLE 3.2.—DIFFERENCES BETWEEN PAIRS OF CHILDREN OF DIFFERENT TYPES OF COMPARISON *

Comparison	*Difference in IQ*
Unrelated children	15.0
Siblings	13.1
Siblings less than 2 years apart	12.0
All twins	7.1
Twins, unlike sex (fraternals)	8.1
Twins, like sex (some fraternals)	6.4
Identical twins	5.1

* From Tallman.[17]

Identical Twins Reared Apart. A number of cases in which identical twins have been separated at an early age and reared apart have been brought to light. Not always is the level of environment very different for the pair of twins, but there are some variations. In 20 such cases the average difference in IQ was 8.2 points, which is a small change from the average difference of 5.4 between 50 identicals who were reared together.[18] The difference is far from that between unrelated children reared apart, which is 15. From this comparison it would seem that heredity is the more potent factor.

Evidence from Foster Children. A neat experiment would be to take a large number of children of mentally normal parents and place half of them at birth in homes with high cultural standards and the other half in homes of low standards, then note the results. The next best thing is to follow foster children who come from average parental stock and who are placed in superior homes

* IQ means *intelligence quotient* (see Ch. XXI for an explanation).

during the first year of life. This has been done in a number of studies. The results agree that superior homes can shift the expected IQ by only a small amount on the average, actually from 3 to 9 points as shown by different studies.

The correlation between the IQ's of foster children and the cultural status of their foster homes was found to be only +.18. The correlation between the IQ's of a matched "control" group living in the homes of their own parents, with cultural status of the home, was +.51. The correlation between IQ of parent and IQ of foster child is generally low, usually below +.20, as compared with the usual correlation between parent and child of +.50.[19] What correlation there is might be due to a tendency to place brighter children in better homes. Apparently the same heredity that determines the cultural status of a normal home also determines very much the IQ status of the child in that home.

Evidence from Orphanage Children. Orphanage children come from parental stock that varies a great deal. Assuming that this stock varies as widely as that for the population at large, we should expect the children to have the average difference in IQ of 15 points that we find among unrelated pairs of children, if they grow up in different homes. Let these children grow up in the common environment of an orphanage, and if similarity of environment is effective, they should become more alike in IQ. Such is not the case. There is a slight indication of a leveling process in orphanage children; those from the lower classes may rise slightly in IQ and those from the higher classes may fall slightly in IQ. But the average difference in IQ remains about the same as for unrelated children reared apart.[20]

Evidence from Training. Another approach to the problem is to start with children of equal average IQ's, and give one group certain training that the other one does not have. The training might be of a general kind, such as additional schooling, or it might be made more specific of the kind that resembles "coaching" in mental-test material.

Nursery School Training. Training of the general type, in addition to regular school training, is given children who attend nursery schools from the ages of two to five. Some studies show

an average increase in IQ of about six points after only a few months in nursery school. But after a year or so, during which both experimental and control groups are treated alike, the difference between the two shrinks considerably. Other studies show a continued benefit lasting through the grades if the children continue in schools of a high type where repeated tests are given.[21] Whether there is a real and permanent improvement in ability, or whether the advance in test IQ is merely a result of living in an atmosphere of psychological testing, is not yet apparent.

Coaching in Mental Tests. A group of children was trained for 78 days in the memory-span test, resulting in an improvement of average memory span from 4.33 to 6.40.* A control group with the same initial ability had a normal growth in span of only .73. After four and a half months without practice the two groups were equal again, and with 22 days of practice in both groups the further improvement was the same for both.[22] In another study, an experimental group was given special training in color naming, handgrip, free association, tapping, and singing tones and intervals.[23] The trained group showed only small advantages in tapping and speed of association, which were lost after three months without practice. Considerable gain was made in speed of color naming, but the advantage was lost in three months. The gain in handgrip was retained for three months but lost after seven. Gains in singing were decided and were retained for at least four months. The general conclusion was that gains involving strength and speed do not leave permanent effects; gains that add new reactions may leave permanent effects.

Evidence from the Feebleminded. It is generally recognized that a large percentage of the feebleminded come from defective family stock. A smaller percentage of the feebleminded arise from causes other than defective germ cells. Injuries at birth, diseases affecting the nervous system, and glandular defects are the most common causes not hereditary.

Hereditary feeblemindedness often acts as if it were determined by a single recessive gene, but this cannot be so, for there

* See Ch. XVII for a description of the memory-span test.

are many abilities, and each one may be determined jointly by a number of genes. It is true that some parents of normal intelligence may have feebleminded children among other, normal children. Among recent ancestors of both parents in such instances would be found an occasional defective. A parent of normal intelligence mated with one of defective mentality might have only normal children, unless the normal parent is also a "carrier" of defective heredity. Two feebleminded parents may be expected to have only feebleminded children, but there are exceptions to this rule.

Identical twins, having the same heredity, should both be feebleminded or both not, except for accidental causes. In 126 cases of identicals studied, there were 11 pairs in which one was feebleminded and the other not. On the other hand, in 101 pairs of fraternal twins of the same sex, 62 both were feebleminded, and in 39 pairs only one was feebleminded. In 139 pairs of twins of unlike sex, 66 of the pairs were both feebleminded.[24] Much room is left for causes other than heredity in producing feeblemindedness, but it is undoubtedly one important cause.

Experiments on Heredity. With lower animals that have several generations within the course of a few years, we can follow the inheritance of ability experimentally.* The albino rat matures rapidly and thus provides a good subject for this kind of experiment.

Tryon has made such a study. In the first generation, 142 rats were given an "intelligence" test in the form of learning a maze pattern. The number of errors in a certain number of trials was the test score. From this group the very best learners were selected to be the parents of one strain of rats, and the very poorest to be the parents of another strain. In Fig. 3.9, at the top, is shown the frequency distribution of scores earned by the parental stocks. The "bright" rats are at the left end of the distribution (small number of errors) and the "dull" rats at the other end.

Fig. 3.9 shows the distributions of the scores made by later generations separated into the two strains. In each generation

* To say "inheritance of ability" is to speak in rough terms. Strictly speaking, only properties of bodily structures are determined by heredity. Abilities are in turn dependent upon bodily structures and their properties.

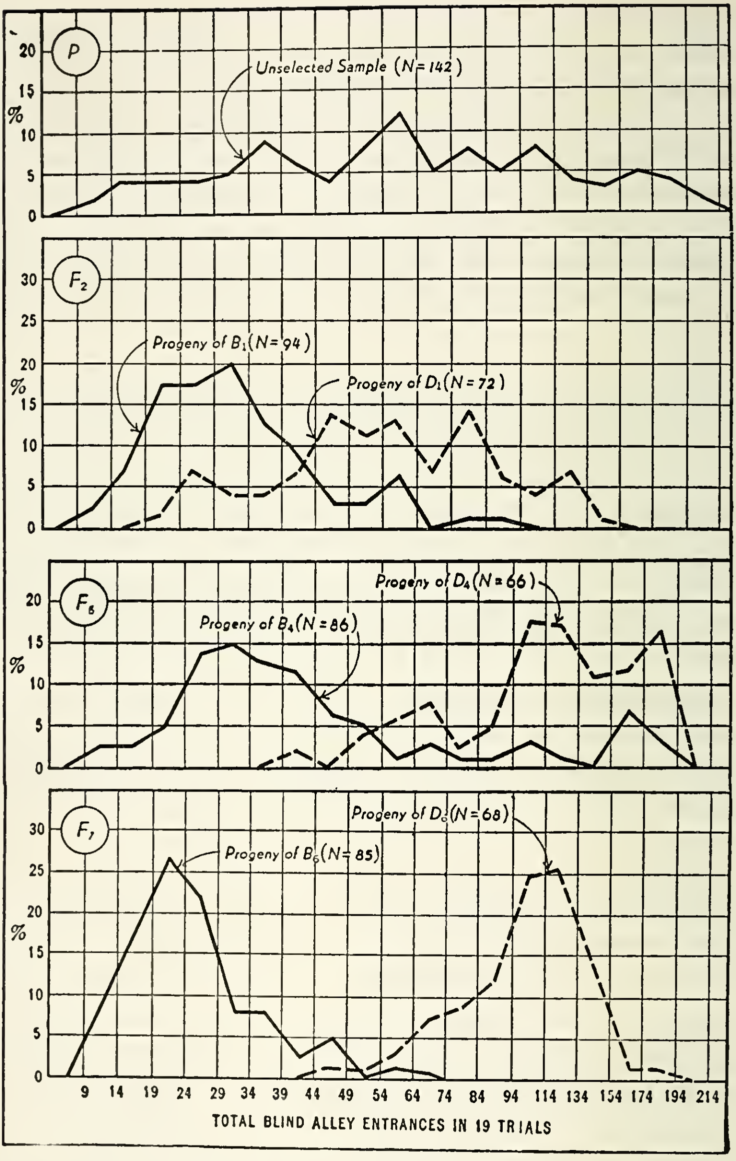

FIGURE 3.9 Frequency distributions of rats scored for learning ability in a maze, beginning with an original unselected generation (P) and showing later generations after selections of best and poorest learners in each generation to be parents of the next. (F_2) means the second filial generation, that is, the "grandchildren" of the original rats, and (F_5) and (F_7) mean the fifth and seventh filial generations, respectively. The best learners are always at the left (lowest number of errors) and the poorest ones at the right. (Data from R. C. Tryon, in F. A. Moss, *Comparative Psychology*, Prentice-Hall, Inc.)

only the brightest of the one strain were kept as parents of the next generation, and only the dullest of the dull strain. Even in the second filial generation (F_2) there was a distinct separation of the averages of the two groups, with a surprisingly small amount of overlapping. In generation F_7 the overlapping was extremely slight. By that time there were two almost pure strains, the "bright" and the "dull."

We are not ready to generalize these findings very far. We do not know whether selective breeding of rats would give similar results for *all* rat abilities. Nor can we say that similar experiments with human subjects would give parallel results. Owing to the similarity of hereditary mechanisms in rats and men, however, and from everything else we know about heredity, the presumption is very strong that we would find similar results in human experiments. If this reasoning is brought into connection with the fact that dull parents tend to have large families and bright parents tend to have small ones, the situation is rather alarming. It would appear that the human race, at least in our culture, is effecting adverse selection so far as favorable heredity is concerned.

Heredity and Other Personality Traits. We have just seen that heredity seems to be more important than environment for establishing the individual's ability levels. Physical characteristics, likewise, are strongly determined by heredity, probably even more than are abilities. Other traits, however, are determined to a much greater extent by environmental forces. But heredity does have its say, even in the case of the most obviously learned characteristics.

Resemblances of Twins and Siblings. The data concerning the role of heredity in behavior traits are far less complete than they are concerning abilities. The reason is that suitable tests and scales for measuring nonability traits are newer and less certain than those for measuring abilities. Results obtained thus far indicate that parents and their children, and brothers and sisters, do show some positive correlation with respect to personality-test scores.

Identical twins show a greater resemblance than do fraternal

twins. For example, in tests of vocational interests, the correlation between identical twins was +.50 whereas that between fraternal twins was +.28.[25] This difference is apparently due to heredity. But note that in tests of ability, the corresponding correlations would be something like +.90 and +.70, respectively. This bears out the assertion that environment affects other psychological traits more than it does abilities.

Breeding Experiments. It is reported in a later chapter (Ch. VII) that differences in general emotionality of rats can be produced by selective breeding. An emotional and an unemotional strain could be produced by selecting the most and least emotional parents. In other experiments of similar kind it has been shown that active and inactive strains of rats can be produced by selection and that the trait of "wildness" in mice is also related to heredity.[26] All of these traits would seem to rest upon glandular bases, and certain overactive or underactive glands very likely depend upon hereditary causes.

Hereditary Traits Are Subject to Change. Hereditary traits of emotionality, wildness, and hyperactivity are of a very general, pervasive kind. And yet, they may be subject to changes in certain individuals. For example, some "wild" mice might be tamed and some of the "non-wild" ones might be made wild by specific treatment. In other words, just because a trait is shown to have a hereditary basis is no reason for becoming completely fatalistic about it and to conclude that nothing can change it. We should regard heredity as merely bending development in certain directions. Later factors bring their bending influences to bear upon that same development, either cooperating with or opposing the hereditary slant.

There is the old and familiar saying, "As the twig is bent the tree inclines," which is undoubtedly true, either literally or figuratively. The point here is that "twigs" are bent by hereditary influences before the birth of the individual and continuing after he is born. Bending influences from the environment get in their work mostly after birth. The earlier they exert themselves the better are their chances of producing important, general results. They must work with or against directions already estab-

lished by heredity, and the outcome is a compromise. The final outcome will depend upon which factors are strongest and in which directions their forces are felt.

Summary

In general plan the nervous system is a most intricate communication system. Its nerves contain millions of microscopic threads or fibers, some of which carry impulses from receptor cells in the sense organs inward to nerve centers, and others carry impulses out from the nerve centers to muscles and glands.

The human nervous system has developed with three rather distinct levels, one superimposed upon the other. The lowest is the reflex level, centering in the spinal cord and the brain stem. The second level, with centers in what is sometimes called the "old brain," also provides mechanisms for our unconscious and semiconscious mental activities. The third level has its centers in the cerebral cortex or "new brain." Some areas of the cortex, when excited, give rise to sensations, of colors, sounds, bodily feelings, tastes, and smells. Other areas, when excited, give rise to muscular contractions. For this reason we say that there are sensory and motor centers in the cerebral cortex. The largest part of the cortex is devoted to the interconnection of other parts.

Every part of the brain, within the same level and between levels, is so much connected with other parts that no activity is uninfluenced by what goes on elsewhere in the nervous system. On the whole, higher centers are dominant over lower ones, but lower ones also determine, to a large extent, what goes on in the higher centers. If there is any one dominant center in the human brain it is the speech center.

Beginning life as a fertilized egg, a developing individual is ready to show responses to stimuli long before birth. There is much spontaneous activity after the fourth or fifth month. At birth many reflex patterns are ready to function, although not perfectly. The newborn child, or neonate, rapidly develops his sensory functions. His development along the lines of motor patterns, adaptive responses, language reactions, and social reactions, is usually sufficiently regular in its sequences that useful growth norms can be given.

Motor control develops according to two principles. More precise and refined patterns emerge out of gross movements (principle of differentiation). Already developed reflexes or learned responses become incorporated into new and more elaborate patterns (principle of amalgamation). In spite of great regularity in development, each child follows in his own unique pattern (a third principle of individuality). These principles apply to other areas of development also.

Development of behavior occurs by maturation (an unfolding of body structures as laid down primarily by heredity) and by learning (effects of stimulation and response). Maturation prepares the child for learning certain behavior patterns at certain age levels. The rate of learning will be greatest when the maturation condition is most favorable.

Through learning, the pressures of the culture in which the child lives make a human being out of him. A child is so adaptable that without cultural pressures he would develop many inhuman qualities. The effects of different cultures are quite obvious in terms of attitudes, beliefs, and other personality traits.

The general question of the relative effectiveness of heredity and environment in determining individual differences in intelligence and in other personality traits has been both challenging and difficult. From studies of resemblances of children and their parents, of ordinary siblings, of twins (identical and fraternal), of foster children, and of orphanage children, certain tentative conclusions can be drawn. On the whole, it appears that differences in intelligence are determined more by differences in heredity than by differences in environment. This is especially true where there have been comparable opportunities. Although there are evidences that heredity influences many other traits of personality, to a larger extent these traits are depndent upon social factors. Significant changes in personality can be brought about in spite of heredity.

Questions

1. Draw a simple diagram to show the complete series of events occurring between stimulus and response, including the structures

necessary for those events—afferent and efferent nerves, nerve center, receptor, and effector.

2. Explain what would probably happen if, by a delicate operation, we could connect the eye with the auditory nerve and the ear with the optic nerve.

3. In view of the known speed of nerve impulses, cite some limitations that are placed upon the quickness of our responses to stimuli in some life situations, for example, playing tennis, typing, driving a car, or piloting an aircraft.

4. What support is given to the idea of an "unconscious mind" in the study of nervous functioning?

5. Why is it incorrect to say that human intelligence is localized in the frontal lobes of the brain? Is there any truth at all in this idea?

6. If some child under three years of age is available to you for observation make a list of the accomplishments he shows, using the list on page 62 as a guide. What are your conclusions?

7. List several criteria or signs by which we can tell whether a certain behavior pattern is primarily due to maturation or to learning.

8. Why do you think the concept of "instincts" was rather prominent in psychology about thirty years ago and why it is not now?

9. List some things about child behavior that could not be credited to the kind of culture in which he lives and list others that could not have come about without the influence of culture.

10. How could a government program bring about an increase in the level of intelligence of its population?

11. How much truth is there in the statement "criminals are born, not made"? How *can* heredity have influence on criminal behavior?

12. The Dionne quintuplets, although having identical heredity and extremely uniform environment, developed unique personalities. Explain.

13. Select an acquaintance whom you know very well and who has outstanding traits. Try to account for those traits from what you know of his heredity and his past environments.

14. Write for your own consumption a short autobiography entitled, "Why I am what I am."

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CHAPTER IV

An Organism Has Needs

THE FIRST important answer to the question "Why does an individual do what he does?" is found in what we call his motivation. Under the heading of motivation come all the internal conditions that stir up activity and sustain activity. External stimuli would be rather ineffective in arousing action if there were not some cooperation of internal help.

Notice what things an individual attends to and what he strives for, and you can depend upon it that those things have some unusual value for him. You may see no value in them, but they promise him satisfaction. Notice from what things the same individual tries to escape. They also point to some disposition within him to avoid such things. The same person at one time seeks an object, and at another time is indifferent to it or even shuns it. Something within him has changed. It is that "something within him" to which we turn our interest in the next few chapters. *A motive is any particular internal factor or condition that tends to initiate and to sustain activity.*

INTERNAL SOURCES OF ACTION

Organisms Are Spontaneous. Suppose, for the moment, that we could eliminate all external stimuli. To do this completely is impossible, but we can approach this goal. Place

an albino rat, the favorite laboratory animal, in a cage by himself, in a sound-proof, light-proof, air-conditioned room. The only important external stimulation will be his contact with the cage. Support the cage on a device that registers every movement he makes. After he has been in the dark 24 hours, examine his record. It will be found that most of the time he has been inactive. Even minutes passed without the sign of a movement. But every two or three hours, there were signs of revived activity, increasing in frequency and in vigor until a climax was reached, and then a more rapid dying out of activity, and a return to quiescence. A rhythm of activity has occurred that can be due only to internal causes.

Place a female rat in a common revolving squirrel cage for a period of a month and let her run as much as she will, for that is the only activity, besides resting and eating, that she can engage in. Record the number of revolutions of the cage each day. If she is a normal specimen, every fourth day she shows a sudden burst of activity, and runs several times as far as on the other days. External stimuli have remained the same from day to day, so the only reasonable conclusion is that some internal factor is at work.

Activity Is Sustained until a Goal Is Reached. Suppose that the first of these two rats, when he approaches one of his regular periods of activity, is given the choice of several things to do. He chooses to eat and, almost immediately after eating, he becomes quiescent. We infer that he was hungry, although we need not assume that he knew he wanted food, that he had any ideas of food, or even felt any sensation of hunger. We may say that his goal was food-in-stomach, not because that is what he seemed to want, but because his violent activity ceased when that state was reached. We must not read into the rat's behavior any human characteristics that may not be there at all.

What Is a Goal? We speak of human goals because we have the power to imagine them and our attainment of them some time in the future. To say that rats have similar goals is to make a very bold assumption. As a matter of fact, we ourselves are completely unaware of many of the things toward which we are striving. In this respect we are on a par with the rat and other lower animals.

We also observe other human beings apparently striving toward something that to them may be an unconscious goal. The best conception of a goal should include all cases. *A goal is best defined as an end status at which sustained activity ceases.*

The water in a river flows until it reaches the sea. A stone rolls down hill and keeps moving until it comes to some stable resting place. If we wished to be animistic, we could say that the water in a river intended to reach the ocean, and that the ocean is its goal. We could say that the falling stone seeks a resting place, that the bottom of the hill is its goal. But we have long since discarded this way of explaining the behavior of flowing rivers and falling stones. These are natural phenomena, with natural stopping points. We must look at mental activity in the same way, if we are to be scientific about it. Mental activity is also a natural phenomenon with its natural stopping places—food in the stomach, escape from pain, and other end points of quiescence. Mental activity comes in segments that persist until certain natural stopping points are reached.

Activity Eases Tensions. What, then, starts the activity, and what is a natural stopping point? A stimulus, external or internal, starts the activity; this is not a new statement. But we must now look upon a stimulus as an irritation, or as something that upsets the equilibrium of the organism. So long as the irritation is present, the organism is apparently under tension, like a stretched coil spring or a taut bow. The human individual experiences the tension. He may also realize just what stimulus caused the tension and what has to be done to relieve it. On the other hand, he may be aware of nothing but the tension, and even that only in a vague sort of way.

The only adequate way of releasing the tension is to remove the irritation or to change it. The irritation may be the lack of something needed or wanted, or the presence of something unwanted, disagreeable, or painful. Mental life is one long sequence of tensions and attempts to relieve them, with the success or failure that ensues. At any one moment an individual may be laboring under a number of different tensions simultaneously. Some tensions can

be eased immediately, and with little effort, while others take hours, or days, or even years.

To live at all means to have tensions, and when all tensions are gone, death replaces life. Fortunately, though tensions are often uncomfortable, they also make life interesting, and the satisfactions of releasing ourselves from them usually more than repay us for the discomfort they entail.

The Source of Energy for Mental Activity. Motivated activity is energetic activity, and the stronger the tension the more vigorous the activity. What supplies the energy? Certainly not the stimulus, for stimuli merely release energy. Internal needs and cravings. although they set up tensions, do not contribute energy; they merely steer or direct its discharge. The vigorous action we see in a strongly motivated person involves strong muscular contractions. This uses the stored-up fuel material left in the muscle cells by the blood and it comes in turn from the food that he eats.

Nervous energy, used to direct the muscles, is of a similar kind. It comes from the food material stored up in the neurones. Nerve cells themselves use surprisingly little food material and can respond for hours without showing fatigue. Failure of receptors and muscles comes first.

There is no reason, therefore, for speaking of a motive as a force, as if it were energy supplied from some mysterious source. Nor is it necessary at all to assume a "mental energy" as a new variety. So far as we know, no more physical energy comes out of the body than is put into it in the form of food material.

Specific Organic Needs

The most elemental factors that initiate, select, or control activity from within the body are the so-called *animal drives.* Their source is in the organic needs of the body. Some of these needs are of trivial consequence for behavior in general, but others are all-pervasive in their effects. Man has them in common with all the animals, but the role they play in man and the greatly complicated ways in which they operate are quite different. Here we are concerned only with the more elemental cravings, such as hunger, thirst, and sex.

Homeostasis. Under the term *homeostasis*, we find the attempt of the body to keep the condition of the blood in perfect order. It is a most remarkable fact that the blood varies only to the smallest degree from a certain temperature and a uniform chemical composition. The proportions of water, salt, oxygen, carbon dioxide, acidity, sugar, protein, fats, and glandular secretions are kept as uniform as possible under all conditions. The moment anything upsets the balance, immediate steps are taken to restore the equilibrium. Nervous control plays no small role in this, and it often results in activity of the entire organism, for some of the adjustments demand things from the environment, such as food, air, and water. The need to maintain homeostasis therefore leads to mental activity of various kinds, and thus it is a general motivating factor. Particular attempts to keep the blood constant will now be mentioned.

Temperature Regulation. It is now known that a part of the brain, the hypothalamus to be more exact, contains an automatic regulator of body temperature.[1] Like the thermostat in your home, that keeps the rooms at nearly a constant temperature, this center in your brain does not let your blood temperature vary more than a slight amount. One part of it, if excited, causes a rise in temperature, and another part causes a fall. During an illness, the balance is sometimes automatically shifted to permit a higher level, and you have a fever. The effect of the higher temperature is to kill some forms of infectious microbes. Behavior resulting directly or indirectly from the dictation of the hypothalamus includes such reactions as perspiration, shivering, building of nests, huts, or houses, maintaining fires, and wearing clothing, and, more recently, air conditioning in summer.

Sleep. Tradition has it that we spend a third of our lives in sleep. No other single activity occupies so large a portion of our time. A center for the sleep reaction is also found in the hypothalamus.[2] Pricking this center in the cat's brain with a needle, or touching it with certain chemicals, has been found to cause sleep. Just why we need so much sleep, or why ordinary rest or relaxation will not do in its stead, is not fully known. The chief virtue of

the sleeping state seems to be to shut out as much sensory stimulation as possible from the nervous system.

Experiments on sleep show that the average person is far from motionless while fully asleep. Recording instruments attached to the beds of sleepers, show that they change their resting poses every 12 minutes, on the average. An individual may be expected to make from 20 to 50 gross changes in position during a single night. It has been found that the greatest depth of sleep comes during the early hours after retiring, and that sleep becomes progressively lighter toward the end of the night's sleep. This is determined by finding the loudness of sound required to cause waking. It is also found that sounds most easily awaken a sleeper just after he has moved in his sleep, and that the frequency of movement is progressively greater as morning approaches. Between movements, the deeper sleep returns.[3]

The onset of sleep is a natural reaction, being brought on by fatigue, monotony, and the absence of exciting factors. It can, however, be fought off when other desires are strong enough and, to some extent, each person develops his own personal habits of sleeping. But it would not be true, by any means, to say that sleep is merely a habit. Persons who are kept awake forcibly for a number of days and nights, when given various tests, can muster sufficient energy to match their normal performance in some respects. Their simple sensory functions may be unaffected, and they make no more errors than usual in certain routine tasks. But most affected are interests, attention, and initiative. After very prolonged lack of sleep there may be hallucinations and other abnormal symptoms.[4]

Hunger. Everyone knows what it means to feel hungry, though rarely does any one in a well-regulated society ever become desperately hungry and so feel the full force of the drive. The source of hunger is in the stomach. When we are hungry, the stomach undergoes a series of muscular spasms that come at the rate of about 10 per minute and last some 20 to 25 minutes unless food enters the stomach. These spasms can be recorded on paper by means of apparatus like that pictured in Fig. 4.1. The subject of the experiment swallows a rubber balloon, which is then inflated and attached, through rubber tubing, to a pneumatic cup or tam-

bour, to which, in turn, is fastened a writing point. At the moment of a spasm, the individual experiences a hunger pang. What starts the stomach spasm is not known for sure, but it is probably a direct sensitivity of the stomach muscles to a slight change in the blood that warns of a dwindling food supply.

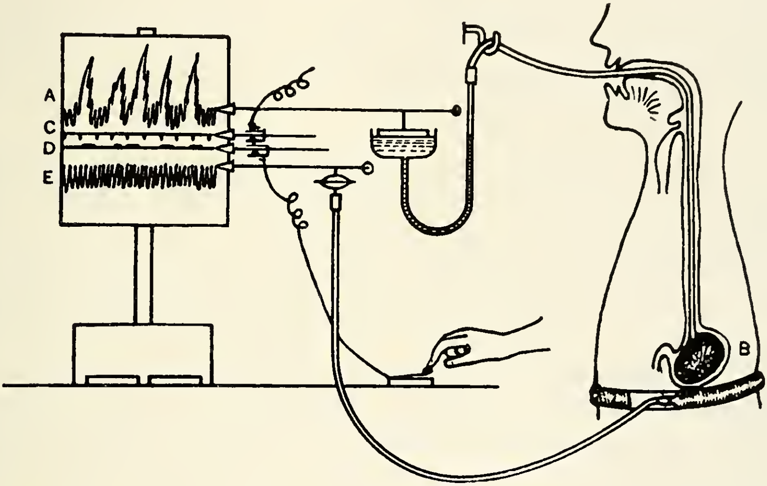

Figure 4.1 The recording of hunger reactions. A is the record of the stomach contractions; B is an inflated rubber balloon; C is a record of the time; D is the record of the subject's reports of feelings of hunger; and E is a record of breathing. (After W. B. Cannon, in P. T. Young, *Motivation of Behavior*, John Wiley and Sons, Inc.)

Hunger and Appetite. A distinction must be made between hunger and appetite. We may say that appetite is educated hunger, to use figurative language. People have a craving for food not only because of actual hunger pangs, but because they have learned that foods can satisfy. The sight of food, even when one is not hungry, creates a desire to eat. The smell and taste of appetizing food also creates a desire to eat over and above that initiated by hunger pangs or in the absence of hunger pangs.

Cravings for Specific Foods. All animals require a well-balanced diet and an adequate supply of vitamins to maintain growth and health. An examination of the diets of lower animals and of man the world over, shows a remarkable balancing of diets, even in the absence of the advice of expert dietitians. How is it that the

right foods are selected? No one knows just how a deficiency of such things as salt, phosphorus, calcium, or things containing vitamin B, sets up a definite search for food containing them, and an avid devouring of these foods.[5] Human diets change adaptively with the climate in which men live. After living on a one-sided diet, men experience cravings for things that would make up for their deficiency. Infants, when allowed to choose among alternative simple foods, come to select a fairly well-balanced set of foods. Many factors in human life serve to pervert appetites and to obscure the natural cravings.[6]

Aversions for Specific Foods. Many harmful things that might otherwise be taken as foods have a disgusting odor or bitter taste and are rejected. Very strong hunger pangs, however, overcome almost any aversion. Behavior of people during famines demonstrates this very clearly. There are some aversions in human beings that are not entirely explainable, for example, aversions to eating meats of many animals, insects, and reptiles. Such foods have never been shown to be harmful. They are as nutritious as many others we do not hesitate to accept. There may be some deeply implanted, negative reaction to them, but, on the other hand, social custom undoubtedly has much to do with these aversions. Infants sometimes eat insects without signs of disgust, but later develop the adult attitude toward them.

Factors Contributing to Appetite. The strength of appetite of a hungry animal can be measured by the rate of eating or by the amount of food he consumes in a given time. Give a hen a supply of 100 grains of corn, for example, and she will eat rapidly at first, then more and more slowly until she stops when satiated.

Certain factors increase the hen's appetite, and similar factors operate in connection with human appetite. After the hen has eaten her fill, remove the grain; then return it, and she starts eating again. When grain is presented a number of times, she may consume as much as 67 per cent more. She eats more from a large pile than from a small one, and more in terms of weight when large grains are presented instead of small ones. Social factors are also important. A hen that has just eaten her fill will eat again when a second eating hen is brought into the situation. Several

additional eating hens induce more overeating than one. As much as 60 per cent more food may be eaten under a social stimulus.[7]

The Consequences of Hunger for Behavior. What a large part of human activity can be traced directly or indirectly to the attempts to put a stop to a few small stomach spasms! A third of our population is engaged in agricultural work, most of which aims at the satisfaction of hunger. Transportation systems devote much of their work to the carrying of foods. Grain exchanges, manufacturers, processors, markets of food, cooks and restaurant employees, contribute their services toward gratification of the same need. Almost every war has had its economic causes; a struggle over dependable future sources of raw materials, including food supply. Great migrations of history have been caused by famine or the threat of famine. All due credit must, therefore, be given to this fundamental human craving.

Thirst. The mechanism of thirst works somewhat as follows. A slight drop in water content of the blood deprives the salivary glands of water. Salivary secretions are reduced in the mouth and throat, and a constricting sensation of "dryness" is aroused there. An urge to seek liquid refreshments is noticed in the form of general restlessness, even before any sensation of thirst arises. Only when the craving for water is intense does any unusual human behavior result, but the struggle over a dependable source of water supply sometimes has great social consequences.

Elimination Needs. For the sake of completeness, two additional urges should be mentioned. Their relative unimportance to behavior in general justifies no more than naming them here. The need to eliminate body wastes gives rise to the urge to urinate and the urge to defecate. While relatively unimportant in themselves, these urges are given considerable attention in Freudian psychology. Freud believed that many of an individual's personality traits arise in connection with his learning to control these urges when he was a child.

The Need for Exercise. A drive that seems dependent upon a specific kind of organic condition is the urge for physical activity. Muscles that are in a healthy, rested state seem to demand

activity that exercises them. This is most apparent in growing children who cannot sit still very long at a time. Growth seems to call for the functioning of the growing organ, which in turn stimulates further growth.

This principle might be generalized to include all growing functions, but this is in the realm of speculation rather than established fact. It does seem, however, that the appearance of some power or ability in an individual carries with it an urge to use that power. The individual is especially interested in those things that he can do well and is likely to be unhappy when his assignments do not make use of the talents he thinks he has.

Some Less Specific Needs

The organic needs just listed are all vital. Whatever other activities they may stir up in the process of their satisfaction, there is one essential response that must be made if the organism is to continue to live. The initiating stimulus, too, is some characteristic organic condition.

In the next motives to be mentioned, the initiating stimulus may be quite varied, although it is usually of a certain kind. The responses by which gratification is achieved may also be quite varied. Furthermore, gratification may be delayed or denied without necessarily endangering the life of the individual. Where there are no natural or obvious gratifying responses, there are often substitute satisfactions.

Sex. The reproduction and survival of a species depends upon internal stimulation. The very complex structure of human nature and the restrictions placed upon the sex impulse by civilized society make the operation of this drive in man an extremely varied and obscure process, very difficult to analyze. Its importance in human behavior cannot be denied. But if we are to study the sex drive in its simple and elemental form, we shall have to look to the lower animals.

The primary internal stimulus for sex craving is in the nature of a glandular secretion or hormone. In the male, it is a secretion from the interstitial cells of the gonads or sex glands. In the female, it is a secretion from the ovaries. Carried by the blood stream, in

the brain it sets in readiness certain patterns of response that would otherwise be quiescent. Interest in the opposite sex, and behavior leading up to mating, are the most obvious patterns of response.

Natural Sex Cycles. In lower animals, sex activity is decidedly linked with the seasons, being most prominent in the spring of the year. The secret of this response to spring is the increasing length of daylight. An accumulative effect of light stimulation through the eye and the brain exerts some influence upon the pituitary gland, which is attached to the lower part of the hypothalamus. One of the secretions from the pituitary gland flows into the blood. If the animal is a migratory bird, it starts its flight northward. At the same time, the pituitary hormone stirs the sex glands into action.[8]

Sex Hunger and Sex Appetite. As in the case of food hunger, we must make a distinction between sex hunger and sex appetite. The latter, again, is based upon factors in addition to the stimulation of the sex hormone, factors derived primarily from experience. Such factors as femininity and beauty in the female, and masculinity and strength in the male, may be effective because of inherited organized response patterns in the human brain. Proximity of the sexes in daily life introduces its strong factor for sex appetite. The cinema and many other forms of amusement also contribute their share of external sexual stimulation. The public demands such entertainment and pays for it, otherwise the purveyors of amusement would change their wares. Sexual tensions, unlike most others, are pleasurable in themselves up to certain degrees of intensity, and this fact calls for means of whetting sex appetite.

Individual Differences in Sex Appetite. One outstanding fact is often overlooked by those who are concerned about the problems of sex. This is the fact of individual differences. Many people act as if they believed the sex impulse were a standard, fixed quantity in every human individual. This is far from the truth. There are many individuals with almost complete lack of sex interest. Women are far more likely to be lacking in sex interest than men. The cause of an individual difference may be a matter of

glandular constitution, not only of the gonads, but also of other glands like the pituitary and the *adrenals* that stimulate the gonads into action. The cause may be personal experience; long repressive training by a sexually repressed parent, a disagreeable sex experience, or a lack of external stimulation. Only when we realize these individual variations can we deal effectively with individual problems.

The Maternal Drive. The great concern of a mother for the welfare of her young is now very largely traced to the presence of a hormone called *prolactin* which is secreted by the pituitary gland. Its effect upon the brain is to make profound changes in the mother's behavior. She shows an intense urge to return to her young when separated from them, to retrieve them to her side when they stray away or are removed, to protect them, and to care for them in many ways.

The power of prolactin is experimentally shown by injecting it into the blood stream of the females who have not yet had young of their own. They become maternal in their behavior and "adopt" the young of other mothers, even from other species, like the hen who adopts puppies or kittens. Prolactin injected into laying hens causes broodiness. Even in roosters it may have the same effect, even to the clucking typical of the mother hen.

It is true that some mothers do not always show motherly behavior toward their young. They may desert their litters, and mother rats may even eat their young. But this should not be taken to mean that they lack entirely the maternal drive. It simply means that some other drive is at the time much stronger than the maternal drive. Mother rats who eat their young probably do so because their diet is deficient in something that is replenished by devouring the young.

Human Mother Love. Mother love in human individuals is also basically dependent upon the same organic factors as in lower animals. But that is not the whole story. These factors could not explain why the human mother continues to lavish affection and care upon a child long after its nursing period is ended. In general, it is true that we become attached to any objects that have been found to serve as an outlet for any drive. And the attach-

ment for the object persists, carrying its own motivation, even though the primary motive no longer directly operates. A child also gratifies many other motives in the mother. Through it she derives the satisfaction that comes from love and affection and from her feelings of superiority. The child is weak and dependent upon her, which adds to her feeling of self-importance, and in so far as she identifies herself with her child, its gain in strength and accomplishment also add to her own sense of worth.

Over and above these factors, there may be, in both father and mother, an innate parental attitude which makes them want to aid and to protect any young and weak specimen, human or infrahuman. To prove or disprove such an inborn behavior pattern would be very difficult. We can at least conclude that the human attitude toward children is a highly complex affair, as compared with the elementary maternal drive furnished by prolactin alone.

Sensitive Zone Demands. In connection with the fulfilment of some organic needs, there are certain tissues that, when stimulated, give rise to highly pleasurable experience. This is true in connection with the normal functions of excretion, of eating, and of sex. In connection with the taking of food by the infant, sucking seems to be a very pleasurable act. The act itself is often continued in the form of thumb sucking or in other ways, even after hunger is satisfied. Though the lips are said to lose their power to give the intense pleasure known to the infant, at a later time, they probably never lose it completely. The satisfaction that many older children and adults derive from handling the lips, putting things in the mouth, and in kissing, testify to this fact. Much of the pleasure from smoking is said by psychoanalysts to be a matter of revival of the infant's sucking response. The act of chewing is also rewarded, to a less extent, by pleasure. This accounts, in part, for the appeal of the common habit of chewing gum.

Origin of Love and Affection. It is very probable that the child's reaction of love and affection begin, to a large extent, in connection with the sensitive zone reactions. No human infant instinctively recognizes his own parents or loves his parents. He has to learn to love them. If a mother strokes the lips or chin

of an infant lightly with a finger, he smiles and coos with pleasure. Let him see her smiling face as she does so, and he connects the pleasure he experiences, and his smile, with the sight of her face. He soon comes to smile and coo at the sight of her, and stretches out his arms to her. As she clasps him to her gently, rocks and cuddles him, she stimulates other sensitive zones.

But this is only one way in which a child learns to value and to love others. Any person whom he associates with the relief from pain or discomfort or with satisfying any other motive, becomes a loved object. Feed the child, give him candy, toys, and attention, repeatedly, and you win his affections, as anyone knows. He comes to show love and affection toward others in proportion as he associates them with the satisfaction of his wants.

Some General Needs

The Urge to Escape. Fear with its accompanying urge to escape from dangerous situations is an obvious tendency in all animal life. There is no particular organ or tissue that originates the stimulus for fear. There is probably a "fear center" in the brain, but the stimulus is usually external. The stimulus that can excite this center and set up the urge to escape is either a pain-inducing one or one that threatens pain or injury.

In the human infant, only a very few stimuli will instinctively arouse fear during the first six months after birth. They include loud noises, sudden happenings, sudden displacement of the infant, or a loss of support and falling. The maturing nervous system later brings out fear reactions to some additional stimuli such as strange persons, things, or places. Some general factors may overcome the potency of these stimuli to arouse fear, for example, if the child is made to feel secure, has developed confidence in those about him, and is free from tension and strain. If he is ill at ease regarding his status in the home, if ignored or neglected by his parents, or if punished or blamed too much, he is more prone to fear.

Fear Reactions Spread to New Stimuli. As the child grows older, certain changes occur in his susceptibility to fear and in his way of expressing it. His growing ability to see connections between things opens up new sources of danger that were totally

ineffective before. He can anticipate injury farther and farther in advance. He comes to sense danger where there was none for him before. A second way of attaching fear to an object is to have a painful experience with that object. That the burned child dreads the fire is an old, trite saying. In more general terms, the child learns to fear objects that are associated with a former fear-provoking stimulus.

Watson set up a fear of dogs and rabbits by the process known as *conditioning* (see Ch. XIV). At the moment a rabbit was presented to a year-old child, a sudden, loud noise was made behind the child. The child reacted with fear to the natural, fear-provoking sound stimulus. The next time the rabbit was presented without the noise, he shrank from it in fear. The rabbit alone was then the fear-provoking stimulus. The fear often transfers automatically to similar objects; to rats, fur muff, or anything resembling the rabbit. In this way fears are likely to spread by conditioning.

Conditioning, however, does not always take place. The more intelligent children in Watson's conditioning experiment, on hearing the loud sound, did not connect it with the rabbit but kept the two separated. But wherever a real connection between an old fear-arousing stimulus and a new one is made in the brain of a child, the fear reaction transfers from the one to the other.

Thus there are two ways in which new fears come about: (1) by the maturing of abilities to sense danger in advance, and (2) by the process of conditioning. In any specific new fear we cannot always be sure just which it is. Both depend upon the associating of new things indirectly with the fear reaction. Children between ages 1 and 2 usually show no fear of snakes. From 2 to 6 they show "guarded" reactions to snakes. By the time college age is reached, two-thirds of the students show fear and even terror. All have by that time heard much about poisonous snakes, boa constrictors, and pythons. Some have themselves had harrowing experiences with snakes, or have known others who were injured by them.

Fear Responses. The first fear responses in the infant usually include the following components, although the total reaction

varies depending upon the severity of the response and the type of stimulus. Some form of withdrawal, be it ever so slight, is nearly always present. Other movements include facial alarm, crying, clutching, trembling, paralysis, and the startle reflex. Older children are taught by shaming and other punishment to avoid crying, clutching, and other tell-tale signs. There is less overt activity, but the trembling, paralysis (at least partial), and other more internal components involving a widespread, organic stir-up, continue, sometimes with disastrous consequences to one's composure and health. States of worry, anxiety, and general nervousness are essentially prolonged fear tensions.

Devices of Escape. The primitive withdrawal reaction gives way to flight, and to other devices for putting distance between the individual and the threatening situation. This can be elaborated in a great many ways often not recognized as real cases of "running away." Much "queer behavior" is actually of this kind. One person, afraid of others, and afraid that his social powers of adjustment are inadequate, becomes seclusive, withdrawing from social contacts. Another, afraid to face reality because it is too painful, resorts to daydreaming and phantasy. Another, to escape from disagreeable duty, takes a "flight into illness." It may seem unreasonable that anyone would resort to physical illness of his own desire, but that is precisely what sometimes happens. Soldiers who are deathly afraid of facing the enemy, at the slightest pretext may develop a lame leg, a paralyzed arm, a blindness or deafness or a loss of the power to speak. They thus escape from disagreeable and dangerous duty, and, at the same time, from the blame of others. Their symptoms are brought on by means of some unconscious mechanism, as yet unknown. They do not realize that their illness is of their own making, and so they also escape all self-blame.

Frustration and the Urge to Struggle. The urge to struggle is an almost universal one. Its most effective stimulus is restraint. Whenever an individual is blocked in carrying out what he starts to do, he is frustrated. He is then likely to struggle or to fight. Hold an infant's arms, legs, and head firmly to restrain his movements, and he soon squirms, stiffens, grows red in the face, strug-

gles and cries. Take food away from a hungry dog or cat; take sugar away from a honey bee; take chicks away from a mother hen; utter a slighting remark to a touchy person; in fact, interfere with the attempt of any animal to gratify a motive, and you may have a fight on your hands. The genuine fighting reaction is aroused only in connection with the failure of other motives.

Differences in the Urge to Fight. Not all animals are equally belligerent. Some are better equipped for flight, with their swift legs and strong wings. They struggle only when flight is interfered with. Some are better equipped to fight and to kill, with their sharp talons and claws and powerful tooth-studded jaws. In most species the male is the fighter. If he does not often engage in combat with members of other species, he fights with other males of his kind over the females and over food, water, and other advantages.

The sex difference in fighting may be bound up with the sex hormones in some way; there is a possibility that the urge to fight is suppressed by the female hormone. Many animals, like men, resort to bluffing before engaging in the more dangerous hand-to-hand combat. They make a great showing of bared teeth, erect mane, hair, feathers or quills, thumping of the chest, arching of the back, and other threatening gestures in the attempt to win a psychological battle without risking their skins. With lower animals this is naturally more automatic and reflexive than it is in man.

Civilized Modes of Fighting. Civilized man retains his urge to fight when thwarted, and his urge to struggle against odds for what he wants. He uses more elaborate and indirect weapons, as a rule, but when these fail, he regresses to the use of more primitive methods. Being intelligent, he can sense the threat of losing his source of livelihood, or love, or of social position, a long way off. In most civilized societies the courts provide a means whereby one can fight for his rights in a way that is favored by one's fellows. International courts have been tried as the more dignified way of settling international disputes, when nations will accept that method, rather than resort to war. Impatience with court procedures and lack of confidence in their fairness leads to a regression

to older and more direct methods. There is probably no instinct of war, or even an instinct of fighting, as some would have us believe, that compels fighting for its own sake. The only fighting of this sort is done in a spirit of play, as in athletic contests.

Substitute Outlets for Anger. If the urge to fight is thwarted because of overwhelming odds, the desire lingers and may find an outlet upon some hapless substitute. A man who receives a severe calling down from his boss at the office must refrain from fighting back or he loses his job. His smothered anger leaves a tension, like all unspent motives, until he vents that anger on his family at home, or upon the rug that he beats for his wife. All of us need such scapegoats as an occasional outlet for suppressed anger. A boy may work his anger off on the woodpile, a girl by practicing on her piano, and an athlete in trying to win from his opponent. We may secure considerable relief and satisfaction from watching a violent boxing or wrestling match or from seeing a decisive fist fight on the motion-picture screen. This is particularly true if we can sense similarities between the one who takes the brunt of the punishment and someone against whom we feel hostility.

Young children learn to suppress their hostility toward their parents and other members of the family because they are punished when they express hostility. The parent is a continual source of frustration because there are so many things he prevents the child from doing. Brothers and sisters frustrate one another because they are rivals for parental affection and favor. Parents are often frustrated by children because there is no longer freedom to come and go as before the children arrived and there are disturbances of rest and sleep and of previously established habits of living. It is no wonder, then, that frictions, jealousies, and resentments develop within the family circle. Occasional violent outbursts should be no surprise to the careful observer. It is the bottled-up, unreleased tension due to hostility that leads to an explosion. There should be harmless ways of letting down such tensions.

One such device that has been used quite successfully with children is known as "play therapy." In this procedure, the child is given some toys to play with, among which are dolls. He is

encouraged to let each doll stand for a member of his family; a "papa," a "mama," an older brother, or a baby sister. A miniature stage is set and he is encouraged to invent a little drama. In such a setting, hostilities may come out that had been unsuspected. The child is allowed to do as much damage as he wishes to the object of his hostility, following which his attitudes should improve. With older children there should be encouragement for verbal discussions of hostilities. Talking often "gets things off one's chest" or "out of one's system." Meeting the child with sympathy and a sense of humor is very helpful.

Frustration and Aggression. A great deal has been said in recent years concerning the causes of aggressive behavior of the undesirable kind. Not only individuals but also races and nations attack others often in a vicious and unwarranted manner. It is probably true that the individual or group that is thus attacked in some manner stands in the way of the attacker, or seems to do so. Violence in the course of labor strikes, in race riots, and in civil and international wars is believed to be brought on by frustration or threats of frustration. The understanding of this principle should do much to aid our thinking about the prevention of violence in a given situation.

While it may be true that aggression is the typical reaction in the face of frustration, it is not the only possible outcome. As a matter of fact, all of us learn to tolerate and to live with frustrations. Whether it is a matter of competition for the use of a certain traffic lane at a certain time, for the affections of a certain member of the opposite sex, or for a coveted position on a team, we may have learned to take the attitude of the good sportsman, accepting a merited loss with good grace. It is the immature individual who must have what he wants when he wants it and whose pride suffers a severe jolt when he loses. It is the mature, civilized individual who can forego some immediate gratifications for the sake of achieving greater future satisfactions or larger social goals. It may be said that each person develops a certain level of *frustration tolerance.* It is true that some develop too much tolerance; they give up when they should not do so. Yet, a moderate degree of tolerance means freedom from unnecessary tensions within one's self and unnecessary strife with others.

The Exploratory Urge: Curiosity. This is an elemental animal drive that has no known specific organic basis. Its seat is probably to be found in some general property or disposition of the nervous system, rather than in some tissue outside the nervous system. An organism faced with a novel situation as yet unexplored by him is likely to drop everything else and to make an investigation. It is as if he asked, when faced with a new object, "Of what value is this to me?" There is no question of this urge to explore and, in man, the feeling of curiosity that goes with it. Who does not feel the invitation to look into a new house that is going up in his neighborhood, or to follow a mountain stream beyond his customary beat?

The human infant is a bundle of curiosity. He wants to see and to handle everything, to manipulate and to exploit it for what it is worth. He asks endless questions, and he never feels quite at ease until he gets some kind of an answer. The average child would continue through life with unabated curiosity to explore and to learn, except for the fact that he gets well enough acquainted with his immediate surroundings to feel secure in them and to get things he wants from them, and except for the fact that his curiosity is discourged by unimaginative parents and teachers. A few carry their childish urge to explore with them through life and may become scientists, trail blazers, or inventors.

The biological importance of the exploratory drive is obvious. An organism thus becomes acquainted with the environment sufficiently to sense those things that threaten pain and danger, and those things that promise the satisfaction of cravings in advance of their arousal. A certain measure of readiness to cope with almost anything that is likely to crop up in the environment is thus established.

The Urge to Play. Not traceable to any organ or kind of tissue, yet depending upon the organic condition of the individual, is the urge to play. The individual rarely plays when tired or sleepy or ill: only when sufficiently rested and in good health. The significant condition for play seems to be a physical state which is conducive to a high level of activity when there are no stimuli with which to contend leading to the serious business of living.

The young of a species are far more likely to play than the adults. The kind of activity engaged in under the heading of play is extremely varied. Almost anything the individual does may enter into his moments of play; running, jumping, chasing, capturing, fighting, sex behavior, manipulating and constructing are all common actions entering into play. Imitation of adult activities is another common element in play. This whole picture has led some biologically-minded psychologists to infer that play is a way of practicing for adult life. Play undoubtedly has this value, but whether play as such was invented for this precise purpose is quite another matter. One could as well say that muscles and nerves that are growing and well-nourished and ready for activity of some kind demand stimulation and activity. From this point of view, it may be that the urge to play is fundamentally the same as the urge to exercise, which was described earlier. The need to exercise supplies the drive, and environment supplies the necessary external stimuli, suggesting what the young individual shall do. The kind of thing done is also determined by other drives acting at the moment. Satisfactions are derived not only in playing but also in playing pursuit-and-escape, fighting-for-victory, and caring-for-children.

Humor. The urge to laugh is a very specific one, leading to only one kind of reaction, but the kind of situation that may provoke laughter is quite varied. If we are to get a laugh from an individual, he must be in fairly good health and in a favorable mood for it. Children laugh along with hearty play, and this laughter seems, like the play, to be a general device for working off excess tension.

An examination of the type of jokes that make adults laugh leads to no sure explanation of laughter, but it is very suggestive. We laugh when the high and mighty individual against whom we have been harboring some unexpended ill feeling is suddenly "taken down." Stories about individuals of high position are passed around and enjoyed with great relish, especially if there is a common resentment against those individuals. Some jokes depend upon a sudden and unexpected turn from the serious to the trivial. Note, for example, the humor of the following answers given by children to examination questions:

A brunette is a young bear.
An oasis is a futile spot in a desert.
A poll tax is a tax on parrots.
A senator is half-horse and half-man.
An antidote is a funny story that you have heard before.
A "Mugwump" is a bird that sits with his mug on one side of the fence and his wump on the other.

We laugh at the stupidities of other people. To some extent this also applies to the illustrations just given. This may be because we ourselves have been caught in the act of stupidities of our own, the aftereffect of which was tension.

We laugh when other people are caught in some disgusting or debasing act. The following jokes are funny for such a reason:

Ed: "George fell down stairs last night with a quart of gin."
Coed: "Did he spill any?"
Ed: "No, he kept his mouth shut."

First little boy: "There goes that Sally Smith. Her neck's dirty."
Second little boy: "Her does?"

A "Safety-Valve" Theory of Laughter. Freud believed that every example of wit depends for its humor upon the release of tensions that are set up in civilized society against the free expression of instinctive motives. The sex drive is one of the most drastically repressed, he believed; consequently the sex joke provokes laughter because it eases tension left by repression. The enjoyment of a pun is similarly due to the sudden escape from the restrictions of the rules of formal grammar and syntax.

A much more comprehensive theory of laughter is necessary to take account of all cases of laughter. The one thing that all laughter has in common is a release of tensions in the course of the usual spasmic diaphragm movements. A general "safety-valve" theory therefore seems best. Laughter, then, serves somewhat the same purpose as play. Their common conjunction is not surprising, from this point of view. The Freudian theory cannot account for playful laughter in which release from repressions seems highly unlikely. The general theory would also account for hysterical laughter. Some individuals, in watching a tense

drama, become so wrought up with tension that they suddenly burst out laughing during otherwise very serious moments. Most modern melodramas provide comedy relief for the purpose of permitting release from long-sustained tensions that build up on the way to a climax.

The Need for Beauty. Practically every writer on the subject of motivation sees the necessity for assuming the need for beauty as a unique motive. It is true that beauty of food or of a member of the opposite sex adds to their attractiveness and to satisfactions in connection with gratification of the elemental needs of hunger and sex. There is no denying, however, that many experiences are enjoyed for their beauty alone. In other words, a seeking after the beautiful is not merely for the sake of satisfying other biological needs.

It is quite possible that experiences that satisfy because of their beauty have beneficial effects upon the body and that complete bodily well-being requires such experiences. The common features of beautiful objects are balance, rhythm, and patterns of sounds, colors, and the like, that have their counterparts in properties of body movements. Body movements are unpleasant if unbalanced. Rhythmic movements are enjoyable. Melodies that can be sung or whistled are preferred to sound sequences that cannot be mastered in some way. This is one defense for placing the urge for beauty in a list with organic needs.

Summary

Living organisms do not simply wait for external stimuli to start them into action. Many internal factors also start activity and act in cooperation with outside stimuli to initiate and to steer activity. The internal factors come under the heading of motivation.

A motivated individual is an individual under tension. Tensions are aroused in a number of ways. The condition of the blood provides a general source of tensions when its composition changes from the normal status. Cravings for food, for water, for sleep, and for a restoration of normal temperature often make themselves felt and express themselves in activity working toward

relief of tension. Other organic needs or demands are identified as sex drive, maternal drive, sensitive-zone demands, and the drive for exercise.

While all of these organic drives provide some specific internal stimulus or condition, not all of them initiate the same responses, each time, to satisfy the needs. Some of them are vital, in the sense that gratification is essential to the life of the individual, while some are not.

Two important motives that derive less directly from organic conditions are the urge to escape and the urge to struggle. The former is the urge to escape from physical pain or to avoid pain when it is threatened. Almost all the things that threaten pain have to be learned by the individual. The urge to struggle arises when a situation prevents the gratification of an urge. Some recognition of the identity of the probable source of frustration is usually necessary. This leads to aggressive action directed at the source, although this is not the only outcome to frustration. There are substitute outlets and substitute objects of aggression and there is developed in each person some degree of ability to tolerate frustrations.

The urges to play, to laugh, and to seek beauty are somewhat tenuously listed with the organic needs. Play and laughter seem to have a similar function of relieving tensions generally, when more specific, unchecked oulets are not available. Experiencing the beautiful may have a real bearing upon organic well-being.

Questions

1. Why is it incorrect to say that homeostasis is a single motivational factor? How many separate factors are included in it?
2. What is the importance of distinguishing between hunger and appetite? In general, how do appetites develop?
3. Collect a few definitions of the term "instinct" from dictionaries or from textbooks. What are your conclusions?
4. Collect instances from biographies that show an apparent urge for the talented person to exercise his talents.
5. Collect some examples of the fact that individuals learn to fear certain objects or situations and that learned fears tend to generalize.
6. Collect examples of aggressive behavior. Try to point out the frustrating elements leading to the behavior.

7. Collect examples of substitute outlets for anger or hostility.

8. Report some examples of play activity. Try to determine what motives, other than the play motive, probably help to determine the kind of play.

9. Cite some examples of devices of escape that you have observed in yourself or in others. Were they recognized as escape devices at the time? Why?

10. In view of the discussion of the urge to struggle, what can you say concerning the possibility of the elimination of war in modern life?

11. Collect 20 to 30 jokes of different kinds and classify them under the several categories suggested in this chapter. Add other categories if necessary.

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CHAPTER V

Complex Motives Develop

The needs or motives mentioned in the preceding chapter are often called *primary,* because they derive rather directly from common biological requirements. The organic conditions that are responsible for them operate to some degree throughout most of the life span of the individual. Only in the human infant do we see their expression in rather standardized form. As we saw in the distinction pointed out between hunger and appetite, the individual becomes educated with respect to his needs and their gratification. He develops some *secondary* needs or motives based upon the primary motives. The young infant has no craving for beefsteak; he merely hungers for food. As he learns to eat beefsteak and it satisfies his hunger, he comes to desire it as if it were an end in itself. He also learns habits of eating, such as eating at certain times of day and with certain implements and table manners. He not only craves food but demands certain ways of eating it. Things that were first means to certain ends become ends in themselves.

In this chapter we shall see how secondary motives develop and how they instigate and control behavior. The education of an individual's motives occurs while he is under the social pressures of the culture in which he lives. The important secondary motives, therefore, have social implications. The list could be about as long as the list of habits we develop. Only certain of the important

ones will be mentioned in this chapter. We shall also see how the social development of motives leads to voluntary action and self-control. A relationship will also be pointed out between self-control and the phenomenon of hypnosis.

Some Socially Derived Motives

Praise and Blame. The two factors, praise and blame are by far the most potent of all social motives and the most useful measures for social control. Every individual regardless of who he is—even the most hardened criminal—likes to be praised and dislikes to be blamed by someone, and for something. The whole system of morals depends upon these factors. The effectiveness of these factors depends upon learning. It comes about in the following manner.

Learned Reactions to Praise. In his cradle the infant learns to differentiate between praise and blame, between approval and disapproval. When he does something cunning or when he complies with the wishes of his mother, she caresses him, embraces him, arousing his love reactions and, on the whole, a very pleasurable state for him. At the same moment, she smiles at him and talks to him in a gentle, approving tone of voice. Repetitions of this kind day after day, arousing pleasure sometimes to ecstatic proportions, teach the child to respond in the same way to the mother's smile and to her approving tone of voice without the original or natural stimuli. When the child is old enough to understand the approving words as well as to react to the tone of voice, the words of praise and commendation are sufficient stimuli to arouse pleasure. The older child also learns that certain advantages follow if he pleases others. He tries to make friends because of the satisfactions that result, though he may not recognize this selfish motive for doing so.

Learned Reactions to Blame. The other side of the picture is similar. When the infant or child does something of which the mother disapproves, or when he fails to comply with her wishes, she may use force, which is disagreeable, or she may administer painful punishment. During this procedure she carries a facial

expression of disapproval, and she talks in disapproving or scolding tones, and perhaps in a loud, shrill, fear-provoking manner. The child comes to dread this tone of voice and later to dread the words of condemnation. He tries to avoid them and to bring in their stead the much more agreeable voice and words of praise. The reaction to words or expressions of blame carries over to other individuals as stimuli, and other individuals, in turn, aid in the conditioning process.

Moral Training. The child is thus given his first lessons in morals and in the bounds of humanly acceptable behavior. He has no inborn sense of right and wrong, no instinctive moral sense. His moral development consists first of the many learned reactions with praise and blame as the "go" and "stop" signals. As he acquires a conception of himself as a person, another important step is made in moral training. Adopting the moral code of his elders and his friends, he is in a position to give himself "go" and "stop" signals. He can praise or blame himself. In doing so, he becomes something like a double person. His so-called "voice of conscience" is separated in a sense from the rest of him. Sometimes he connects it with his self, and sometimes he does not. Conscience stands for the sum total of such motivating forces built up on the basis of social pressure. Other desires are continually running counter to it, with inevitable conflicts, which we shall discuss in more detail in the next chapter.

The Relative Value of Praise and Blame. The question is sometimes asked: Which is the more effective in motivating behavior, praise or blame? Some experiments have been performed to answer this question. The results do not all turn out the same way, but, on the whole, either praise or blame is more effective than none at all, and praise is more likely to get positive results than blame.

The experiments of Hurlock with school children in grades 3, 5, and 8 support this conclusion.[1] Psychological tests were used with 136 subjects, both boys and girls, and both Negro and white, on two different days. Dividing the children into three equated groups after the first test, to one group she made a speech praising their work for several reasons; to the other group she made

a speech reproving them for poor work. The third group was neither praised nor reproved; it served as a control group. The second test was then given. Of the control group, 52 per cent raised their scores; of the praised group 79 per cent, and of the reproved group 80 per cent. Praise and blame were here about equally effective. Other findings were:

1. Older children responded more to praise and blame than younger ones.
2. Boys responded more than girls to praise and blame.
3. Bright children responded to the special motives more than dull ones, but the bright were relatively more responsive to blame and the dull to praise.
4. Negro children responded slightly better to praise and the white children to blame.

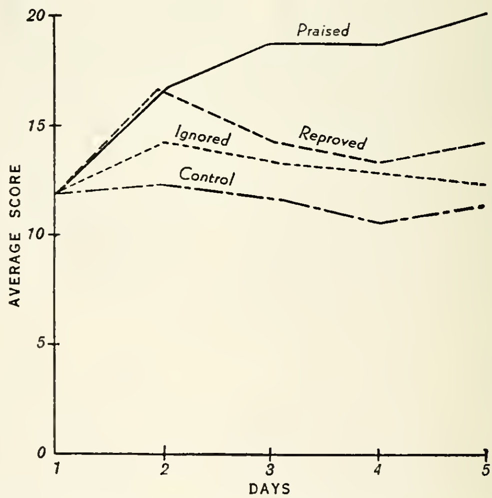

Figure 5.1 Effects of praise and blame upon efficiency of adding by children. (From P. T. Young, *Motivation of Behavior,* John Wiley and Sons, Inc.)

The effects of repeated praise and blame, however, are not equal, as shown by another experiment by Hurlock with children in grades 4 and 6. Tests were carried out over a period of five days with four groups who took drill tests in addition. One group was praised before beginning every test after the first, and one was reproved, both of them while standing before a third group, who

heard the praise and blame. The third was called the "ignored" group. A fourth group was the control. The results are shown graphically in Fig. 5.1. It is clear that on the second day, praise and blame were equally effective, as in the previous experiment, but from that time on, there was a widening gap between the two motivated groups. The ignored group gained on the second day, but lost continually thereafter.[2]

One cannot apply these conclusions universally without further examination. For university students the results might be different. For football players a coach tries to sense when praise is needed and when reproof will have more effect. In general, a too-confident team needs some reproof, and a discouraged team needs praise. This coincides with Hurlock's finding that the dull and the Negro children improve relatively more under the effect of praise, whereas the bright and the white children improve more under reproof than under praise. One's own standards of attainment and his degree of satisfaction with past successes no doubt have much to do with the matter.

The Urge for Ascendance. Every person, said Alfred Adler, wishes to be the upper dog; no one wants to be the under dog. The "will to power," said Nietzsche, is the prime motive of life. Certainly the desire to master and to dominate is a strong one in some individuals. In almost any group of social animals one can find leaders and followers. Most leaders have to work to attain their positions and to hold them. The struggle to reach the top among men and among nations is a never-ending one.

Dominance in Social Groups. Among a colony of barnyard fowls, there is often found a regular hierarchy among the cocks and among the hens. Hens show their rank order at feeding time. Hen A pecks B, C, D, and all the rest, and is pecked by nobody, all giving way to her. Hen B pecks all except A; C all but A and B, and so on. Hen Z is pecked by everybody and pecks nobody. Dominance is dependent upon age, strength, and intelligence, but it changes slightly from time to time owing to changing conditions. In a colony of monkeys there is usually one in command, and a second one to take his place when he is away from the group. Not many challenge the head men in such a colony, and at the

lower extreme the weakest and most stupid do not challenge anyone. The youngest and weakest is often the favorite of the head man, until he misbehaves.

Varieties of Human Leadership. The factors that make leaders in human groups are much more numerous. Superiority and inferiority are measured on many different scales, depending upon the field of activity. Fortunately there are numerous fields of endeavor in which human beings can strive for a measure of superiority. Almost any individual can surpass in something, easing the tension that may have been set up by feelings of inferiority, and deriving the satisfaction of mastery and accomplishment. The desire for prestige may express itself in the struggle to amass wealth, to gain political power, to excel in athletic prowess, in dramatics, in the arts, in science and learning. It may show itself in less worthy ways such as in trying to "keep up with the Joneses," in social climbing, or in beer-drinking contests and the like. At any rate, the universality of the competitive spirit, at least in the Western World, is so great that one wonders how anything like a communistic society would have an opportunity to succeed or would long satisfy.

Rivalry and Competition. It is common knowledge that a runner will make better speed ordinarily when running against an opponent than when running alone. Most people respond to the challenge of competition with added effort and zeal. It does not require psychological experiments to prove this point. And yet, it requires accurate experimental tests to show just *how much* gain is to be expected from the spur of competition, *when* there will be a gain and when there will not be; for, at times, and in some individuals, the challenge of competition has the opposite effect.

An experiment of Whittemore's is a good illustration.[3] Boys worked in groups of four at the task of copying newspaper stories with rubber type. In some trials they were instructed to "Try to get as much work done as you can, remembering that both the quality and the quantity of the work you do will count in your final score. Don't attempt to beat your fellow workers." At other times they were instructed to "Try to beat your fellow workers,

remembering that both quality and quantity count in your final score. You may use any method you see fit to employ in keeping track of the progress of your competitors. Compete!" The typical result was that the individuals did 26 per cent more work under the instruction "Compete!" The quality of the work, however, was poorer. This is probably because the factor of speed was more easily observed in the competitors, and so the boys took on themselves a set for speed.

Experiments have been carried out to discover whether individuals exert themselves more under the spur of personal gain versus the spur of gain for the group in which they cooperate. Will a person extend himself more for personal competition or for team competition? All the results show clearly that the challenge to personal superiority is more effective than that to cooperative superiority. Sims found that in some simple psychological tests a "control" group, not motivated by any special instruction to compete, gained 8.7 per cent in a short training period, a group working under the desire to win as a team improved 14.5 per cent, whereas a group motivated by personal competition improved 34.7 per cent.[4] These results are based upon the average individual. There are, as usual, great individual differences. Some work harder for their group supremacy and for the love of cooperation; in contrast, some fail to gain, and some even lose, under the spur of any suggestion of rivalry.

The Urge to Submit. Submissiveness is often given as another natural tendency, in almost direct opposition to that of ascendance. Whether or not the child is born with an instinctive pattern for giving up in the face of great odds against him is hard to say. Certainly he has sufficient opportunity to learn that it sometimes pays to give in rather than to stand and fight or to keep struggling for supremacy against impossible odds. The very weakness and helplessness of the infant in its positive efforts against the world predispose him to submit to the large and the powerful. To him, his parents tower above him as giants. His height, when standing, is only a third of theirs. The adult cannot appreciate this difference without imagining a giant 18 feet tall standing by his side. The analogy is real to the child. At a moment's notice he can be

lifted bodily, swung into the air, and tossed about. This lesson learned in childhood probably persists throughout life. It is undoubtedly an important factor in the tendency for taller and heavier men to gravitate to commanding positions. School superintendents, bishops, business executives, and chiefs of police average slightly taller and heavier than teachers, preachers, and other employees.

Lessons in Ascendance and Submission. Growing in size and in strength, the child finds other objects and other individuals over whom he can dominate, and he learns devices by which he can even make those giants known as parents come and go at his beck and call. The world becomes divided into two classes in this respect; the things over which he can dominate, and the things to which he has to submit. A further discrimination is made as to methods; one class of things submits to some of his methods and not to others. Ascendance or submission will occur in response to an object or situation according to which of the two leaves the less tension for the individual. "Battering one's head against an unyielding stone wall" only increases the tension. Giving up too easily leaves tensions in the form of regrets and unsatisfied cravings. It is important to find out when to give in and when to persist with the possibility of reaching the goal.

Sex Differences in Submission. There are some individuals who are easily reconciled to submission and even derive satisfaction from the act of submission. Women, because of their general muscular weakness as compared with men, and because of the lack of the belligerent urge, but not because of any intellectual weakness, have traditionally taken the submissive role as between the sexes. Modern women, however, have deserted their passive acquiescence to this state of affairs. This is possible because in modern society the premium upon muscular strength is less, and intellectual accomplishment counts for more. In some of the South Sea Island tribes women are the dominant sex in political and economic matters. Thus, we see that the question of the dominant sex is largely a cultural matter, though the biological factors have had their undeniable influence.

Gregariousness. Gregariousness means the tendency for individuals to seek their own kind and to live in groups. The term in itself does not imply any instinctive urge to be with others just for its own sake, though such an element does probably exist in those species that live in flocks and herds, as compared with the more solitary ones. There is plenty of opportunity for an individual to learn the advantages of living in groups, and many other motives are satisfied by so doing, including the finding of food, water, and mates, and the protection against common enemies. Like any motive, gregariousness can become satiated, and there are times when people shun the company of their kind and wish to be alone. This need not mean that in them the urge is lacking. In some, like the hermit, a painful experience may entirely overcome any social urge that is present; to avoid further pains they live alone.

The Urge to Get Attention. There are some individuals, a great many in fact, who are not content unless they get attention from others, even though it may be unfavorable attention. Attention with blame or reproof is better than none at all. To be ignored is painful. Such individuals resort to all kinds of devices to gain this end. We are more likely to ignore a person who behaves properly and we let him alone because he does not tread on our toes. The result is that the attention-getter is forced to commit some socially disapproved act in order to gain the attention he craves. Parents and often teachers teach otherwise well-behaved children "naughty" and even criminal habits without realizing it.

The thing to do is to ignore the unwanted behavior. See that it is not rewarded, and that more socially worthy behavior reaps the reward of attention if not the appropriate praise. Much criminal behavior develops and is confirmed by the very reverse of this procedure. Some special devices developed as attention-getters or as methods of gaining other ends are temper tantrums, wearing radical clothing, talking in a loud, boastful manner, or some other form of eccentricity.

Imitation and Sympathy. There is much imitation in human behavior, but not much of it that is of a compulsive character. If

there is any instinctive urge to imitate the actions of others it is very limited in scope. Watch an audience at a football game and you will see that at crucial moments some people lean forward in their seats, some going through the motions of the runner or the tackler on the field, in abbreviated form. This is known as *mimetic behavior.*

A child, in the first stages of learning to talk, sometimes echoes sounds and words that he hears as if compelled to do so. In a playful manner he imitates his elders in rather complex performances, even though he does not appreciate what he is doing. For example, a three-year-old boy, having watched a carpenter go through the process of fitting and hanging a door, a day later rehearsed the whole performance in substance, including the smoking of a pipe, sawing, planing, grunting at the proper moments, and also swearing.

Man the Prime Imitator. Contrary to common opinion, the ape and the monkey are not the prime imitators of the animal kingdom. Man holds that distinction. He cannot imitate movements that he has not the power to observe, and he does not necessarily repeat them immediately after observing them; but repeat them he often does. He finds that it is often to his advantage to do so. It saves him a more rigorous and lengthy period of organizing the same movements all by himself.

Among the lower animals, many birds have the gift of being able to repeat sounds they hear if their vocal organs are equipped to do so. This is true particularly of parrots, crows, and magpies. For some reason the ape lacks this particular power to imitate sounds, and most efforts to teach him to speak human words have thus far failed.

Sympathy. Sympathy may be regarded as the imitation of an emotional response or attitude. To see someone else suffering in pain is sufficient stimulus to give the sympathetic person a similar, though probably milder, suffering. To see someone weeping in grief tends to set off weeping in the sympathetic observer. To see another's horror-stricken face gives us a mild fear reaction. There may be some instinctive basis for this, but there is no doubt that we have to learn to be fully sympathetic. Until we have ex-

perienced grief at the loss of a loved one, another's grief for the same reason strikes us with little force. But having wept with others in response to a common loss, the sight of weeping is later a substitute stimulus for some tendency, at least, to weep. A conditioned response has been set up (see Ch. XIV).

Some General Principles of Motivation

Multiple Determination of Behavior. Scarcely any human action is the outcome of a single motivating factor. Motives cooperate, and sometimes they clash, with consequences to be discussed in the next chapter. But they rarely, if ever, exert their influence in pure form. An example will be given that has to do with economic behavior.

Economic Behavior and Its Motivation. Economic behavior includes all those activities of production, transportation, buying, selling, and trading, of the goods of commerce that we consume, and the services required in this connection. Time was when economists spoke of " an economic motive" or of a "profit motive" as if it were a single unitary urge to engage in economic activity. This is far from the truth so far as the psychological point of view is concerned. In fact, the motivating factors behind a single act such as buying food are many. We spend our dollars for food not just to appease hunger, but for many other reasons. We buy and wear clothing for a number of reasons. We buy the services of beauty parlors to gratify a number of desires.

The Buying of Food. Of the dollars spent for food in the United States in a year, how much is really spent to end hunger pangs? What part of that money is spent for the gratification of other cravings? We have no direct answer to this question. But to see just how complex this segment of our economic behavior is, we may pay some attention to an analysis made by an expert jury of eight psychologists, and eight economists and home economists, who were asked by Thorndike to give their judgments. He asked them to state what percentage of the average dollar that is exchanged for food is spend to gratify each fundamental desire. The combined verdict is seen in Table 5.I.[5]

TABLE 5.1.—ESTIMATED PERCENTAGE OF A DOLLAR SPENT FOR FOOD THAT CAN BE ACCREDITED TO VARIOUS MOTIVES

Motive	*Percentage*	
Hunger		52.0
Sensory pleasure		19.5
taste and smell	16.0	
sight and sound	3.5	
Social		14.0
companionship	3.0	
approval of others	4.0	
welfare of others	3.0	
entertainment	4.0	
Protection		6.0
from cold, heat, wet	1.5	
from animals and diseases	3.0	
from pain	1.5	
Comfort		3.0
Sex entertainment		2.5
Others		3.0
Total		100.0

The Law of Maximum Satisfaction. A general law applies to the operation of all motives. It states that at any moment an organism strives for the maximum satisfaction. Among several alternative satisfactions requiring the same expenditure of energy, it will choose that one which seems to promise the maximum returns. A rat, when offered water or food after being deprived of either one, chooses the one he needs more. If offered water plus food, versus only water *or* food, when both hungry and thirsty, he chooses the combination.[6] These are very simple examples of what we do on a larger scale every day.

The Law of Minimum Effort. Economy of effort is another rule of behavior. Tensions call for the expenditure of energy in order to ease them, but there is also an urge to attain a goal with the least possible effort. Lower animals in their simple tasks show this.[7] Let rats learn that they may reach food by opening either of two doors. Load one of them with a 20-gram weight and the other with a 50-gram weight. They soon come to choose the lighter one. Let them learn two alternative paths of equal length to the food, then place obstacles 25 and 35 centimeters high in the two paths, respectively. They choose to climb the lower one 96 per cent of the time. Give them a choice of a narrow and

a broad elevated pathway. Eighty per cent choose the broad one. In this connection think of the human urge for labor-saving devices. Laziness has been the "mother of invention" because of this law of minimum effort.

Effort, Persistence, and Will

The Regulation of Effort. Motivating factors release energy but in varying degrees. The struggle to reach a goal may be very strong, or it may be a half-hearted attempt. What determines whether or not an individual will put forth his best effort to gain what he wants? Various factors can be mentioned.

(1) *Strength of Motive.*—Obviously, one factor is the strength of the motive itself. Other things being equal, the more vital the need, the more urgent the desire, the more effort will be released. This law is illustrated by the rate of eating which diminishes as hunger is increasingly satisfied.

(2) *The Apparent Requirements of Energy.* The output of energy is regulated by the apparent difficulty of the task. We reach for an apparently heavy weight with greater force than we do for a light one. But if the task seems far too difficult, effort decreases to zero.

(3) *Obstacles in the Way* This factor has two opposite effects. Smaller obstacles invite the necessary added energy, and the overcoming of them is gratifying. Obstacles that loom so large as to seem insurmountable lower the expenditure of energy; the individual wilts before them. Which of the two reactions will occur, however, depends upon what one has learned to do with obstacles. One person has learned by past rewards that it pays to put forth energy in the face of great obstacles, whereas another has had even small ones removed from his path without his trying, and so expects someone to come to his rescue whenever he faces a new one. Children, forced to attempt tasks for which they are not ready, failing, become inert before them. Repeat this many times and the child forms a habit of giving up. Some small measure of success is needed to encourage anyone to put forth *any* effort the next time it is needed.

(4) *Nearness to the Goal.* In general the nearer an organism approaches a goal the harder he works for it. A rat running through a maze usually moves toward the food box at increasing speed as he aproaches it. A lure almost within reach calls forth supreme efforts in the face of great opposition. A distant goal, too far in the future, may call forth but feeble efforts. If one must work toward a remote goal, like a college degree, a vocation, or marriage, it is helpful to set up frequent sub-goals along the way. It is one important characteristic of adult human nature that the lure of more immediate and more concrete goals can be foregone for the sake of greater and more worthy future goals, or that individual gains can be foregone for greater social ends. These are two important criteria of being human and being grown up.

The Results of Effort.—Physiologically, the increase of effort involves widespread muscular tensions. Typically, there is the clenched jaw, the set lips, the tense and set muscles of respiration, including the diaphragm. It will be found, too, that muscles of the arms, legs, and neck are innervated. Tests have shown that, on the whole, such muscular tensions facilitate mental work like memorizing, reciting, and adding. But too much tension hinders mental efficiency, especially the more precise performances of complex tasks.

The Persistence of a Motive. In the gratification of organic needs the urge to activity ceases when the stimulus is removed. With other motives, activity usually ceases when some goal is reached. But there are some activities we enjoy doing, in which there is no natural stopping point; for example, conversation with a friend, playing a new game, or working at a series of crossword puzzles. In these cases we sooner or later reach a point of satiation where the tasks lose their original appeal; we tire of them, and to be forced to continue them would be decidedly unpleasant. It is not merely a matter of fatigue, for we may turn to another task with renewed relish. Assuming that no other counterattractions have come into the picture, the urge to indulge in these tasks has apparently died a natural death. Perhaps the desire for the novel task is an important factor here. The lesson for industry is well recognized. Millions of workers are forced to keep at their monotonous

tasks hour after hour, day after day, and month after month. Only some other fundamental motives keep them at such tasks. The monotony could be made more endurable if workers sought avenues outside their work for the gratification of the desire for novelty.

Interrupted Tasks. What happens when an individual sets himself to work upon a task that can be completed and he is prevented from completing it? Experiments throw interesting light upon this question. Subjects were set to work upon a number of tasks, like writing down a favorite poem, molding a clay animal, making one's monogram, working puzzles, and the like. In half the tasks the experimenter, under some reasonable pretext, interrupted the subjects, and in the other half they worked until the tasks were finished. Afterward, the subjects were suddenly asked to write down lists of the tasks they had been given to do. The result was that the unfinished tasks were remembered almost twice as often as the finished ones. The conclusion of the experimenter, Zeigarnik, was that the assignment of any task sets up a tension, just as any fundamental motive does, and that the tension persists until the task is done. Unfinished tasks *perseverate,* that is, they tend to crop up in memory because the tension underlying them has not been released.[8]

This theory is borne out by the fact that individuals who were interrupted in a task showed a decided urge to return to that task when opportunity was given them to do so. Let the material of the task lie within reach, and let the individual have a free moment, and he takes it up again. He may perform a similar task as a substitute, without realizing it is a substitute; for having finished this one, he shows less inclination to return to the original one. There are, however, various degrees of tension for finishing tasks. The task must appeal to the individual as something worth finishing. We know some individuals who have apparently formed a habit of not finishing tasks, while for others to leave anything undone is seemingly a great sin. There are also many other factors that may strengthen or weaken an intention to finish a task. The effect is weakened by: (1) an immediate repetition of the task, (2) a lapse of time, (3) fatigue or emotion during the task, and (4) too difficult a task.[9]

"Will Power." You are probably wondering why, in all this discussion of motives, the term "will power" does not appear. "Will" is a common-sense term; not a scientific one. When an individual is exerting what we call his "will power," what is really happening? First of all, he is determined, which is to say that his motives are exceptionally strong. Second, he persists and struggles for a goal that we regard as morally right or praiseworthy; and third, he resists temptations. Psychologically, this means that his social motives, based upon the love of praise and the fear of censure, have the right of way over basic desires, such as the urge to escape pain or to revel in sensory pleasure.

Common sense also believes in "freedom of choice" or "freedom of will" to do as one chooses when faced with alternatives. From a scientific standpoint, there can be no undetermined choice. When "we" choose one thing rather than another, consciously our perceived self is associated with the course of action. The course of action itself is selected by the determining factors, external and internal. Even so simple a choice as that in response to the instruction, "Choose any number between one and ten," is not free, but determined. Introspections will reveal some of the determining factors in making choices, though they cannot reveal all. However, they reveal enough to suggest determinism strongly.

Moral Responsibility. The moralist will immediately ask the question, "If all actions are determined, how can there be any such thing as moral responsibility?" The first impact of the belief that actions are fully determined has been unfortunate. Adolescents may conclude that because of this fact they are not to blame for what they do, and they are therefore given free license to do as they please. Some who are concerned with the treatment of criminals have taken this fact to mean that since the criminal is not responsible for his actions he should not be punished. He is the victim of circumstances, therefore why hold him to account?

The belief in determinism of human actions does not mean that we should do away with morals or with punishment. It merely gives us a clearer insight as to how and why moral training should be brought about. Moral behavior is socially approved behavior. All of us who make up our society jointly decide what actions we

want or do not want in other people. We can encourage desirable behavior in others, and discourage undesirable behavior, by applying some very simple psychological rules: to see that desired actions are rewarded and undesired ones are not rewarded or are punished. While simple in principle, these rules are not always easy to apply. They will be discussed further in a later chapter (Ch. XV).

We expect that every individual who earns the right to live in society without exceptional external restraints being imposed upon him shall develop self-imposed restraints. He normally develops these under the dictation of praise and blame, reward and punishment. If an individual reaches adult years without attaining the usual adult self-determination, then he is given the opportunity for special education (reform), or else, because of his lack of proper self-regulation, he is segregated for life where he can do no one harm. This is the scientific way of looking at criminal behavior and its treatment.

Voluntary Control of Actions. There are certain actions that we commonly call volutary, as contrasted with reflex or with automatic, habituated actions. The secret of voluntary actions is not completely solved, but it has been recognized for a long time that a voluntary action is always preceded by some idea of the act to be performed or of the goal to be reached and that it depends upon the higher brain centers. A voluntary action also often follows a choice of two or more alternatives for action. There is always at least a brief moment of conflict between two or more tendencies to act, and then a choice. That is why one may feel as if a voluntary act requires effort, or sometimes seems to be made "by force of will." The conflict sets up strains of effort.

Voluntary Control Is Verbal Control. Another element can now be suggested with some assurance. A voluntary action is almost always a response to our own language mechanism. It works something like this. One thing a child learns very early is that his vocalizing brings magical results. First, his cries and other sounds arouse action in others, and then words add their magic as instruments of control of other individuals. Other persons' vocal sounds also become potent simuli for the control of his own movements. He finds that it pays to obey such commands as "Bring me the news-

paper," or "Keep your feet off the chair." He responds almost automatically to such stimuli; not always, but almost always, when in the right attitude. It is as if spoken words become directly connected with his motor centers. The result is apparent in a typical experiment on *suggestion*.

Suggestion and Suggestibility. Fig. 5.2 shows the plan of the experiment. The subject is standing erect, blindfolded, with a thread extending from his neck to a device that registers his sway-

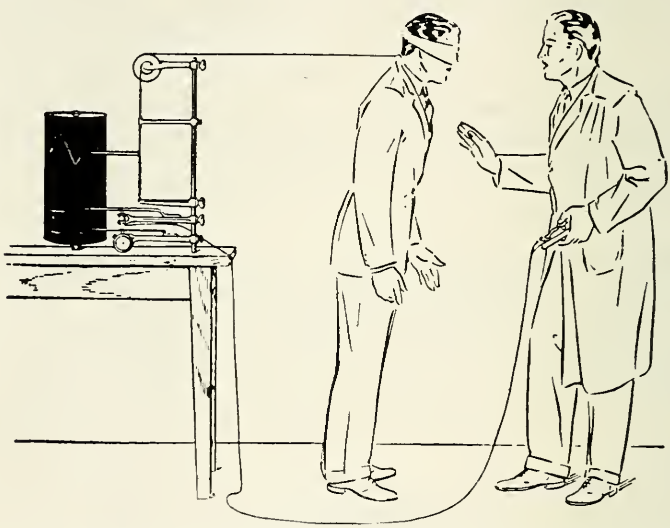

FIGURE 5.2 An experiment on body sway in response to verbal suggestions. The subject is told repeatedly that he is falling forward. His swaying movements are recorded on a smoked drum. (After C. L. Hull, from J. F. Dashiell, *Fundamentals of General Psychology*, Houghton Mifflin Company.)

ing movements forward and backward. The experimenter stands in front of him and gives the repeated suggestion, "Imagine that you are falling forward, forward, forward, forward . . ." The normal subject will soon comply, even unknown to himself perhaps, and sway in the forward direction, some subjects to the point of losing their balance. The subject's muscles are responding rather directly to a verbal stimulus. There are individual differences in this, some people being less suggestible in the test than others. A very few may even lean backward. We call them *negatively suggestible*, or *negativistic*. They seem to have the contrary

set to disobey. Very few obey the suggestion, either positively or negatively, so completely as to lose their balance, because there is a self-imposed set not to do so.

Responsiveness to this type of suggestion varies with the age of the child. It is at its maximum between the ages of 6 and 9. Fig. 5.3 shows curves of responsiveness to suggestions of a somewhat

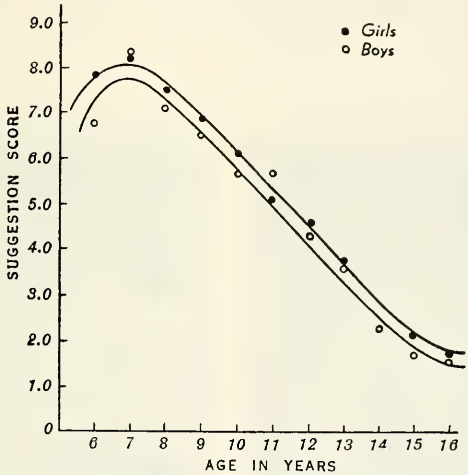

FIGURE 5.3 The relation of suggestibility to age and sex of the individual. (From C. L. Hull, *Hypnosis and Suggestibility*, D. Appleton-Century Company, Inc.)

different type, but the facts are very similar for the swaying test. From these curves one can see that, as the child grows older, the direct responsiveness to veral stimuli rises quickly to its maximum, and then falls gradually, up to the age of 16. The decrease in suggestibility comes partly because more and more the child resists outside stimuli, and responds more and more to self-imposed sets. This raises the question as to what are the self-imposed sets.

Autosuggestion and Self-Control. In the same experimental set-up it can be shown that the individual sways in response to his own verbal suggestions. We call these *autosuggestions.* If the individual merely thinks intently of falling forward, swaying forward begins. This phenomenon is technically known as *ideomotor action* because an idea immediately precedes the motor response. Ideomotor action is probably the secret of voluntarily controlled

actions; they are responses to autosuggestions, either in the form of words or imagined actions or ideas of other kinds. It is the secret of self-control. On the football field when our team is with its back against the goal line, we shout, "Hold that line, hold that line!" In any determined voluntary action of our own, we do a similar thing without realizing it. We furnish our own "cheering," stimulating ourselves verbally with commands to do or not to do an act. This is possible because of the great complexity of the human brain.

A B

FIGURE 5.4 The two pictures illustrate two effects readily obtainable in a hypnotized subject—an illusion in A and a muscular spasm in B. In A, the subject is holding a glass of water which he has been told is a powerful, exotic perfume. Note the expression of pleasure and that he holds the glass some distance from his nose. In B he had been told that he cannot open his eyes. He is trying hard, but without success. (Courtesy of L. F. Beck.)

Hypnosis. Hypnosis is a state of heightened suggestibility The hypnotic trance itself is brought on as a result of suggestions. The typical operator keeps suggesting to his subject that he is going into a deep sleep, except that he can still hear and respond to the voice of the operator. This places his nervous system more and more at the mercy of the verbal stimuli uttered by the operator. It is small wonder that, in the popular opinion of hypnosis, "a stronger will overcomes a weaker one." It is true that the hypnotized subject gives way to the extent that he permits the operator's

verbal stimuli to replace his own. But he does so voluntarily; he is willing to be hypnotized, that is, he orders his brain and its motor appendages to respond to an outside voice. Rarely, can an individual be hypnotized against his "will." He will not ordinarily do anything under hypnosis against which he has strong resistance or moral feelings.

Lack of space forbids our mentioning the many startling phenomena that can be produced under hypnosis in response to words of the operator. Fig 5.4 illustrates two such phenomena. But it should be pointed out that nothing done in response to hypnotic suggestions cannot be done, and is not done, without the hypnotic state. All our lives we are bombarded with verbal stimuli urging us to do this and exhorting us to do that. Sometimes we meet the suggestions with a receptive attitude and they take effect. Again, we meet them with a negative attitude and we do the opposite or do nothing at all. The effect of suggestions upon the growing child is most potent during the ages from 6 to 9, if the results like those represented in Fig. 5.3 are generally true. The lesson in this for those interested in character education should be obvious.

Summary

Human motivation includes many urges to action in addition to those that can be traced directly to organic drives. These urges, again, are identified by what the individual seems forced to do: to seek human companionship; to gain attention; to imitate; to strive for supremacy, or to submit to superior powers.

Among the most potent motives that serve to control human action are the urges to gain praise and to escape criticism or blame. Moral control and moral development depend directly upon these social motives.

Most of what we do is the outcome of not one motive at a time but a number of motives operating simultaneously. As a general rule, an organism at any moment tries to achieve the maximum satisfaction at the cost of minimum effort.

Self-control and voluntary action in general are outgrowths of the effort to satisfy social motives—to gain praise and to escape the criticism of others. A voluntary action is essentially a response to

our own verbal commands or suggestions, in other words, our response to autosuggestions. An illustration of this is seen in experiments on suggestion and hypnosis, in which the verbal suggestions of the experimenter acquire an apparently immediate response in the subject of the experiment.

Questions

1. Make a list of the qualities that make people leaders and tell why they so operate.
2. What bearing does this chapter have upon the relative merits of communistic, totalitarian, and democratic governments?
3. Discuss the psychology of self-control and tell how self-control develops.
4. How much is true and how much is false in the idea that the normal person has a moral sense?
5. Make your own estimates of the percentages of the motivation that can be attributed to each factor in Table 5.1 and compare them with the estimates given there. Can you account for any discrepancies?
6. If all of our actions are determined by causes, why is it of any use to speak of self-control? Discuss.
7. How much truth is there in the idea that in hypnosis the hypnotizer's will overpowers the will of the subject? Explain in psychological terms.
8. Explain why girls are generally more suggestible than boys, and why seven-year-olds are more suggestible than those younger or older.

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CHAPTER VI

Conflicts of Motives

Motives would not be so bothersome, as they sometimes are, if we had to deal with only one at a time. A child spies a lollypop, reaches for it and gets it into his watering mouth. He sees his mother preparing a dose of bitter medicine and he runs away to hide. Even when the motivation behind an act is more complex, decisions may be relatively easy. For example, a man buying a car finds in a certain model just the color and design he wants, it is economical, has power and comfort, and is sold by a friend. A student has no trouble in avoiding a certain eating place if the waiters there are inefficient and lacking in courtesy, the decorations shabby, the food greasy, and, to cap it all, he was shortchanged there. Unfortunately, such easy and direct choices are not the rule. We are entirely too complex for that.

Making Decisions

A child offered either pudding or cake for dessert is likely to hesitate and to waver for a time. A male student may vacillate between spending an evening studying a distasteful subject which he knows he must study or else fail in the coming examination, and spending an evening at a movie with an attractive specimen of femininity. A young man finds it difficult to decide between two careers, one in law, the other in journalism. There are factors pulling and repelling him to and from each

possibility. Until the matter is decided in one way or the other he lives in a state of heightened tension. Now he wavers in the one direction, now in the other. The tension may become so unbearable that he may toss a coin or use a similar gambler's method of deciding the matter. Any decision seems preferable to the disagreeable stalemate. He may give up a cool, analytical weighing of advantages or disadvantages in favor of following his "hunches." He may call for outside help and ask that someone decide for him, especially if his parents have always made decisions for him or if his own decisions in the past have not turned out well.

Deliberation. The best and most realistic way of making a choice, as most mature individuals realize, is to analyze and to weigh all the advantages and disadvantages on both sides. This takes time, for the factors involved do not rush to the fore all at once. It takes time for them to appear, and then, later, some of them are forgotten. It is difficult to keep them all in mind at the same moment.

Benjamin Franklin, in one of his letters to a friend, describes in detail how he treated all doubtful matters.[1] He said, "My way is to divide half a sheet of paper by a line into two columns; writing over the one *Pro* and over the other *Con*. Then, during three or four days' consideration, I put down under the different heads short hints of the different motives that at different times occur to me, *for* or *against* the measure. When I have thus got them altogether in one view, I endeavor to estimate their respective weights; and where I find two, one on each side, that seem equal, I strike them both out. If I find a reason *pro* equal to some *two* reasons *con*, I strike out the *three*. If I judge some two reasons *con* equal to some three reasons *pro*, I strike out five; and thus proceeding I find where the balance lies; and if after a day or two of further consideration, nothing new that is of importance occurs on either side, I come to a determination accordingly."

Franklin's method may seem too slow and stilted for the modern, streamlined world, but one must admit that it is ideal where there is time. Another great aid is to talk over the pro's and con's with other individuals who are less vitally concerned in the outcome. The old saying, "Two heads are better than one," is

almost always true if they do not have the same biases and prejudices. The wide use of deliberative bodies in democratic societies is justified on the basis of this psychological fact.

Rejected Motives. When a decision is reached and the die is cast, what happens to the rejected motives? A number of things can happen. Some choices are made with decisiveness and finality. In this case, the rejected motives, which were probably none too strong by comparison anyway, seem to die a natural death. The satisfaction with the final choice and with the ending of the strained period of indecision is sufficient to dissipate any appeal of the vanquished desires. One may intentionally or unintentionally avoid stimuli that would tend to rearouse them. One builds up defenses against their return by disparaging them. Having chosen one of her two appealing suitors, a girl begins to give herself verbal reasons why the rejected one was not so desirable after all. She devalues his strong points and plays up the importance of his weak ones. Good salesmen know that they must do a similar thing with a customer even after he has signed on the dotted line. They continue to tell him what a good car he has bought and review again the good points of that model. To avoid stimuli which may remind him of rejected models they avoid mentioning those models. Other results of rejected motives will be brought out in later discussions.

Irritational Decisions. The decisions just discussed were made almost entirely on what may be called the verbal level. Remember that voluntary behavior, including decisions, consists in responding to verbal stimuli or to similar autosuggestions. We often decide matters, not in a reasonable way but sometimes, and all too often, in a highly irrational way.

A certain young girl was determined to marry a young scoundrel. Her guardian confronted her with facts to show that he was unworthy of her and that his parents were encouraging the marriage in order to share the home left her by her parents. She finally agreed that if the facts could be proved she would give up the idea of this marriage. But when the time came to listen to the evidence she flatly refused to hear it. She herself could not account for the strong hold the young man had upon her. She realized that it was an irrational desire beyond her control.

Unconscious Motives. The psychoanalysts would say that this girl's strong, unreasonable fixation upon her young man was due to an unconscious motive. They maintain that a large percentage of motivation is below the threshold of consciousness. Some go so far astray as to speak of an unconscious mind as if each one of us possessed two minds, a conscious one and an unconscious one. Each mind is then conceived as a little man inside the outer man, a conception that must be rejected from the viewpoint of science. There is some truth in their idea of unconscious motives, however, so let us try to see what it is.

G. Stanley Hall once said that the human mind is like an iceberg—nine-tenths below water and one-tenth above. The part above corresponds to the conscious part and the part below to the unconscious part. This is a better idea, since it makes the mind all one. But, at the very beginning, we defined mind as mental activity and not as an object or thing. We must recognize that some mental activity is conscious and some unconscious in the sense that some can be observed introspectively and some cannot. We must also recognize that some levels of the nervous system function consciously and others do not. This is one accepted idea of unconscious mental activity. There is also another accepted idea.

According to Watson, *unconscious behavior is unverbalized behavior.* In other words, what the psychoanalyst calls unconscious is really below the highest level, or below the level of the speech mechanism. An unconscious motive, from this point of view, is one that is unanalyzed and unknown. The person is not entirely unaware of it; he simply cannot tell anybody what it is. He cannot even tell it to himself, which is another way of saying that he does not understand it.

To make this more real, consider the child who has not yet learned to talk. He gets thirsty, becomes restless, and makes a big fuss about something. He does not identify the kind of irritation that is acting upon him. At a later occasion he runs to the sink where a similar craving was gratified before and makes gestures indicating that he is ready to drink. Still later he learns to say, "I wanna drink," or "I thirsty," which are signals that he associates with the irritation and that are set off in response to it. He some-

time observes a connection between the sensation of thirst and his own verbal response. He is then aware of the nature of his own desire. In a similar way many other desires get labels attached to them. But many never do. There is also reason to believe that some desires that have had labels associated with them may have the associations broken later. From this point of view, conscious activities are therefore verbalized activities—those concerning which we can make some verbal reaction. Fig. 6.1 illustrates the action of unconscious motives

Figure 6.1 Under hypnosis these two young people were given different instructions. She was told that after wakening she would be depressed by the pictures on each right-hand page. He was told that he would be very much interested in the same pictures. The photograph was taken after both had been wakened from the trance. Neither remembers the instruction given under hypnosis. All of us are influenced by similar unknown and unremembered "instructions" much of the time. (Courtesy of L. F. Beck.)

Unconscious Conflicts. When two or more conflicting motives lack verbal labels they may still indulge in a battle royal. The individual is aware only of the tension of the struggle and with some of its results. He does not identify the contenders and the whole affair is beyond voluntary control. He may do things that he himself recognizes as queer, for example, he has a silly compulsion to count the cracks in the sidewalk or to run his eyes over the boundary lines of objects as he passes them. And he may find himself mentally exhausted and unable to make even the simplest decisions. More facts concerning unconscious conflicts will be brought out shortly, but first let us see how some of the typical mental conflicts arise.

How Conflicts Arise

No one escapes conflicts. They are the normal fate of every complex individual. They stir some individuals into accomplishments of the first order, and they throw others into the depths of utter despair. They arise more often in connection with

some motives than with others. According to Adler, the serious conflicts that come to the attention of the practicing physician, the psychiatrist or psychologist, center around three important phases of life: Adjustments as to (1) social status, (2) occupation, and (3) sex life.

A

B

FIGURE 6.2 Two examples of how an unconscious conflict involving guilt can influence what we see and what we think. The two young people had been told separately, under hypnosis, that each had taken some pennies that did not belong to him, had bought some candy, and had destroyed the evidence of his crime, keeping knowledge of the misdeed from his mother. In A, the young woman reports seeing round objects resembling pennies in an inkblot picture. In B, she reports having had a dream that dramatized in symbolic form her guilt. As she tells it, the young man, who has a similar conflict, is very puzzled. Both were obviously disturbed and felt sure that these experiences had a bearing upon what was troubling them. (Courtesy of L. F. Beck.)

The contending factors are usually found among the following motives: The urge to escape; the desire for love; the desire for approval of others and for aproval of one's self; the desire to dominate; and sex. The conflict may take the form of a struggle in the face of a thwarted motive; circumstances in the environment make fulfilment of a desire impossible or very difficult or seemingly hopeless. Frustration and failure are in store for every individual at some time or other. How will he adjust himself to them? The conflict may be entirely internal, that is, a clash between two incompatible cravings, or, broadly conceived, it may be a clash between a motive and external forces.

Failure as a Source of Conflicts. In a civilization that stresses success and frowns upon failure as much as does ours, the young

of the species learn very early to place unusual evaluation upon success. What will happen when one fails, as everyone must?

The Level of Aspiration. In the first place, failure is a relative matter. What to one man is a welcomed success is to another a rank failure. It all depends upon one's *level of aspiration.* When faced with any new task and invited to participate in it, we aspire to perform at a certain desired level. We set this level in comparison with what others similar to us have done in the task or by what we ourselves have done in similar tasks. We set our mark high enough to keep up our self-esteem but low enough that we cannot surely fall too far below it. We make our first attempt. We change our level of aspiration accordingly, raising it if we succeed, lowering it if we fail. If in our own estimation we succeed or fail in one task we shift our level of aspiration accordingly in other tasks that follow.

Experiments have also shown that in laboratory games each person tends to keep a rather constant ratio between his level of performance and his level of aspiration.[2] Individuals differ as to the width of the gap between the two. Each person has his own constant error in estimating his own ability in the next trial and this holds true for this person in a number of tasks. Call it self-confidence or fool-hardiness, or what you will. These are the normal facts concerning the effects of success and failure when a person is competing with his own standards set for himself.

Inferiority Feelings. But when competing with others of his kind the story of failures is quite a different one. The performance of one's fellows then sets the standard. Comparisons are constantly being made between individuals. Parents and teachers compare a child favorably or unfavorably with others. Children take up the game and make their own comparisons. The way to avoid criticism and unfavorable comment is to win at least a part of the time. The child's evaluation of himself depends upon it. When he is made painfully aware that he is inferior, conflict arises, his desire for approval is thwarted, and he is left with an unresolved tension.

Adler one time maintained that every feeling of inferiority goes back directly or indirectly to a physical handicap; a weak heart, liver, stomach, lungs, even a weak brain. The individual

senses this handicap only in his failure to compete with others. A study was made of several hundred students who were willing to confess their feelings of inferiority and, at the same time, a check was made with the student health office to find out what physical handicaps they had had. The amount of agreement between the strength of feeling of inferiority and physical handicap was very small indeed.

We must look elsewhere for the source in most cases. It may prove to be a matter of personal appearance, an intellectual handicap, an economic or a social insecurity, or a moral inferiority, *real or imagined.* The last part of the statement is stressed because in so many cases it turns out that the very thing the person feels inferior about is something in which he is not actually inferior. In this case it may be that his constant failures, as he judges them, are not failures at all. Supposing that they are real failures, he casts about to find the reason. If he is willing to admit that the cause lies within himself, he may pick upon an insignificant factor to prevent himself from recognizing another that would be much more painful.

In a canvass of students, including 175 men and 100 women, an amazing number reported having inferiority feelings of four types. The results are briefly summarized in Table 6.1. The stu-

TABLE 6.1.—PERCENTAGES OF MEN AND WOMEN STUDENTS WHO REPORT FEELINGS OF INFERIORITY OF DIFFERENT KINDS *

	Percentage Reporting Inferiority Feelings			
	175 Men		*100 Women*	
Type of Inferiority	*Formerly*	*Now*	*Formerly*	*Now*
Physical	60	40	56	55
Social	60	58	65	65
Intellectual	58	29	25	64
Moral	37	17	25	18
None at all	8	10	2	9

* From G. W. Allport.[3]

dent population in this particular university is rigidly selected as to intelligence and to some extent as to social status. Yet more than half of them reported the sting of inferiority in social and intellectual matters. The only conclusion one can make is that their

aspirations were set entirely too high. The advice to "hitch your wagon to a star" has broken many a spirit on the rocks of an impossible ambition. It is often psychologically unsound.

Moral Lapses as Sources of Conflict. In the preceding chapter brief reference was made to the moral training of the child. It was pointed out that this comes about chiefly through parental approval and disapproval, reward and punishment. When the child does what he knows his parents approve, if there has been love between parent and child, he feels secure, expecting continued love. This means also continued gratification of other wants for which he is so dependent. When the child does something that he knows his parents disapprove, he anticipates punishment, loss of love, and loss of assurance of the usual care and attention.

Development of Moral Self-Control. In our Western culture, there is a strong emphasis upon the development of moral self-judgment. This comes about as the child is rewarded for self-control. As he adopts his parents' moral standards (a process that Freudian psychologists call "introjection"), he meets with their hearty approval. He also learns to care about what others outside the family think of his actions. His parents also use this as an incentive where the family and community standards agree.

Development of Feelings of Guilt. In the process of developing moral self-judgment, feelings of guilt emerge. Guilt feelings are to failure to meet moral standards what inferiority feelings are to failure to meet achievement standards. The individual condemns himself as he would expect to be condemned by others. In view of the manner in which feelings of guilt develop, guilt is actually fear of expected punishment. It is also fear of loss of love and respect and the security that is implied in love and respect of one's fellows. It is true that one does not think of guilt in these terms when he feels guilty, but psychologically that is what it is. Intense or long-continued training makes feelings of guilt arise automatically and unconsciously. In some instances, the punishment has been so severe that the individual's conscience operates in a most compulsive and drastic manner. Even a trifling breach

of the moral code may throw the person into a panic of self-condemnation.

Parents should be careful to grade the severity of the punishment to suit the child and the situation. Some children are more sensitive to punishment than others. Some parents are too easily horrified by some misdeed of a child because their own consciences are oversensitive with respect to that type of behavior. This is especially likely to occur in connection with sex behavior that deviates from that prescribed by the moral code.

Moral Training; Excessive and Deficient. Many of the psychological, medical, and social difficulties of individuals, including mental and nervous diseases, delinquency, and crime, stem from the mismanagement of moral training. On the one hand, where moral training has been too rigorous and severe, the danger is likelihood of neuroses and psychosomatic disorders. Neuroses are popularly known as "nervous breakdown" of one kind or another. Psychosomatic disorders include such bodily ailments as stomach ulcers, asthma, colitis, allergies, and the like. On the other hand, where moral training has been lax, the result is likelihood of delinquency and crime.

The child with over-strict moral training is likely to show a fearful, inhibited, shy, over-nice, clinging type of disposition. He is beset with internal conflicts which may express themselves in terror dreams, attacks of anxiety, and compulsive, ritualistic behavior. He may suffer excessively from headaches and other physical ailments. His determination to control himself at all costs keeps him in a state of almost perpetual muscular tension such as when one exerts effort of any kind. Not being able to do many disapproved things himself, he may try to prevent others from indulging in those things. Many "reformers" have been of this type. At the very least, they make other people feel uncomfortable in their presence and hence tend to be unpopular except with others of like disposition.

Delinquents and Criminals. It is now generally recognized that the infant and child who does not receive parental love and affection has lost the best basis for moral development. Inhibitions of his undesirable behavior must be then enforced upon

him from sources outside the family. There is almost no fear of losing love and affection, for there has been very little to lose. The program of development becomes one of a battle of wits to see how much the child can get away with without being punished. There is little if any feeling of guilt for a misdeed. It is in such persons that we find complete absence of remorse when later in life they happen to commit murder. While such a person is free from internal conflicts due to guilt, he is in frequent conflict with people around him. The delinquent and the criminal are not, therefore, ordinarily neurotic individuals, as some have believed. The best remedy would seem to be something that would make up for the lack of childhood training by building up strong desires for love, affection, and respect and by providing the means whereby those desires can be gratified. The fear of the loss of those rewards would be the means of moral self-regulation as in the normal individual.

The Family as a Source of Conflict. The normal child is born into a family, grows up in it, and is subject to all its thwartings, its social demands, its standards, and its internal jealousies and strifes. In the family are laid the bases for most future difficulties as well as triumphs. Only a few causes of conflict will be mentioned here.

The Struggle for Independence. The individual begins life as a parasite, living upon the blood of its mother. Life is gained without effort, there are almost no adjustments demanded, and there are probably no internal cravings. Being born must be something of a shock to most infants, as the psychoanalysts point out. Then it is subject to rude external stimuli and to occasional internal distresses. But by simple movements of its arms and legs and vocal organs it can usually secure prompt relief and it is content to be the helpless center of attention that it is, for some time.

The first conflicts may come when someone restrains the infant's movements or tries to teach him habits of control over the processes of elimination; or when he is weaned from the nipple and thus deprived of his pleasures of sucking and is taught to eat new kinds of foods. After he is able to get about with his own mode of locomotion, curiosity leads him on to investigate his

world. He is frequently stopped, first by a rap on the knuckles and then by a sharp, "No, no." He has already been conditioned to love his mother and father. Their punishment comes as a shock and he develops both love and hate toward the same person—a conflict in itself. He finds himself restricted and thwarted on every hand. He is bossed by everybody and can boss nobody.

Growing older and stronger, he is normally given a larger range of freedom in proportion as he is ready for it, but not always in proportion as he demands it. His real goal, whether he is aware of it or not, is to be transformed from the helpless infant to the self-sustaining, self-managed adult. Every individual naturally desires this. The freedom to gratify all his normal desires requires it. Yet there are many factors that prevent this transformation from coming about. Too many parents find the management of their children much simplified, from their own point of view, by demanding immediate obedience without question, by making decisions for the child, by fighting his battles for him, rather than to take the necessary time and patience to help him to learn to do these things for himself. Some parents actually resent signs of growing independence in their child. They want the child to remain young and helpless. It feeds their feelings of superiority and it holds the object of their love bound to them as long as possible. Many children become reconciled to this type of treatment because it is pleasurable and easy. They are all right so long as they do not have to leave the parental roof, or try to meet the demands of adult love, or make an adjustment to some vocation.

Incompatible Standards. A source of difficulty arises from the inconsistency between the standards learned in the home and those met outside. Parents have always belonged to the "older, more conservative generation." The young ones meet either more or less strict codes of conduct in the changing world outside the home. In this fast-moving era the gap is likely to be wider than ever before. If the home brings its old-world customs and codes from a foreign culture to bear upon the child, his adjustment to outside standards is even more of a problem.

Love Attachments and Conflicts. According to Freud, every individual goes through several stages in the development of his

love life. Remember that what one loves or becomes attached to will depend upon the stimulation of his sensitive zones or upon other pleasure-giving or tension-relieving stimuli in connection with the satisfaction of any cravings.

Self-Love. The infant's first love object is himself. His pleasurable sensations have the highest value for him. He may learn that he can arouse and prolong them by stimulating his own sensitive zones. If this lesson is too well learned and is not forgotten, the self-love may continue throughout life, making the love attachment to other individuals difficult if not impossible.

Fixations Upon Parents. After self-love comes love for the parents. The mother, because of her more constant attendance upon the child, has the greater opportunity to fix its love reactions upon her. Freud maintains that every male child shows a natural preference for the mother and every female child for the father. This was found to be true in many of his adult patients whose love lives were traced back to early childhood. But the study of infants themselves does not bear out this conclusion. If there is any such preference, the parents probably encourage it, even unknown to themselves. The parent may introduce an element of romantic love into the situation. A widow who is left with sons, having her romantic love thwarted, turns to her male children as partial substitutes. Sidney Howard's play, "The Silver Cord," is based upon this theme. In this play the mother grapples her two sons to her, and resents their love for other women. One escapes, but experiences difficulty in transferring his full affection to his wife. The other breaks off his engagement and returns to the protecting arms of his mother. Eugene O'Neill's play, "Mourning Becomes Electra," is based upon the theme of the fixation of the love of a daughter upon her father and a deep hatred of her mother, her female rival.

If too much parental love is a bad thing, too little can be just as damaging. Two young parents who wished to bring up their child along "scientific" lines, knowing of the dangers of parental fixation, went to the opposite extreme. The child was never unnecessarily handled, never kissed or caressed. When it came time for the child to talk she remained mute. This continued until

she was three when a psychiatrist was called in. He found her with a general attitude of resentment and negativism (stubbornness). Taken out of the home and shown some demonstration of affection she soon began to talk. A normal amount of affection seems necessary for the growing infant. It is built to receive affection, and any parent who does not show at least a moderate amount is as bad for the child as the one who overdoes it.

In general, the unwanted and unloved child lacks the usual zest for living. He feels insecure, suffers from anxiety, is negativistic, depressed, and morbidly quiescent. His physical health is likely to suffer in that he fails to exercise and he takes insufficient nourishment. Children kept in institutions, without the experience of loving and mothering, often present the same picture. The close contact with an attentive, loving mother seems necessary for the physical and mental well-being of the infant. The relation of parental love to moral training has been discussed in earlier paragraphs.

The "Homosexual" Stage. When the child goes outside the home to play with other children he soon gravitates to groups of his own sex. They have things in common and gratify certain cravings by group activity. Boys come to resent the intrusion of girls, and girls form their own closed feminine circles. In this period unfortunate attachments sometimes arise. There may be sex play and sex talk with its accompanying pleasurable tensions of excitement, and these pleasures become associated with the individual who was present or who obviously aroused them.

A certain amount of this education is desirable. Boys develop at this stage their sense of loyalty to others, admiration of desirable qualities in other boys, and the capacity for making friends. This lays the basis for cooperative group endeavors in later life. But carried to excess, and in some cases where attachment to particular individuals becomes exceptionally strong, as when one child develops a "crush" on another, there may be disastrous consequences. The individual is left strongly educated to love only members of his own sex, and he often fails to make the adjustment to adult love life.

Sex Conflicts. We have seen that many of one's love habits are

already well formed before the specific sex drive comes on the scene. The sex hormone coming into the picture creates quite a disturbance. Interest in the opposite sex is aroused where before there had been homosexual interests and even some disdain for the opposite sex. The change is not quite so abrupt as this, for the child has had plenty of opportunity to observe adult romantic love and it has no doubt entered into his thoughts and his play for a long time. Some individuals can remember what to them were strong romantic attachments to childhood sweethearts long before the age of puberty. The shift from homosexual attitudes and interests to heterosexual ones is thus made more gradually and painlessly than some writers would lead one to believe.

The chief sources of sex conflicts in our civilization are two. One is the drastic social taboo against even mentioning sex life, and the other is the increasingly long time interval between the coming of the sex drive at puberty and the age of marriage. The former sows its seeds of trouble in the immature child; the latter gets in its devastating work during adolescence. The former source is fortunately losing some of its unnecessary importance with the increasing frankness with which sex matters may be discussed in a matter-of-fact way, even with children. The other source is probably becoming more serious in that the economic structure makes early marriage less and less possible. This is no place to attempt to give a solution, for the problem is essentially an economic and social one.

Conflicts in Marriage. The motives that prompt two people to speak the marriage vows are indeed very complicated. It is a mistake to think that the erotic motive is the entire reason. It may be a desire for security—economic, social, or psychological. It may be a desire for social prestige, or for a companion to whom one can speak without fear or reserve. It may be merely a response to gain social approval, because marriage is expected of normal adults. It may be a desire for children, for whom, after all, the custom of marriage was instituted. There are other desires in the two contracting individuals which neither can analyze or express in words.

Whether their hopes and expectations can or cannot be expressed in words, some of them are bound to be frustrated. Most marriages are launched with a measure of romantic love which serves by its emotional intensity to smooth over many differences and to adjust the habits of husband and wife to one another. But often the two are expecting quite different things from marriage. Things they thought they wanted turn out to be unimportant and desires, unverbalized and therefore unrecognized before marriage, come to the fore. Children come, and with them sources for possible jealousy and charges of neglect. Husband or wife finds that the partner does not fit the picture of his or her romantic ideal. Love attachments of childhood not outgrown interfere with complete love of the mate. Economic difficulties bring loss of mutual respect. The glamour of romance wears off and one or the other seeks to recoup the glow of youthful courtship by attachments outside the family. Death of the mate may be unbearably frustrating. All these are well-known factors for conflicts some of which may reach the divorce court though they do not by any means always end there.

Marriage at its best is the most psychologically satisfying mode of living yet devised by nature. At its worst, it can be anything but satisfying. It should be regarded as a career by all who expect to enter into it, with the necessary study and preparation given to it that are essential for success in any career.

Some Results of Conflict

Repression and Its Consequence. When any craving is forcibly inhibited by an opposing motive, usually a social one, we speak of repression. This is not the result of deliberation and a decision made on the verbal level. The individual is set, by his moral training, to avoid the recognition of certain desires or tendencies in himself. The subject of sex, being taboo, the child avoids it. Hatred for one's employer or for a parent is kept under cover because it is the wise and admirable thing to do. We hold our tongue when we would like to vent our spleen upon an associate. Such inhibitions are necessary if we are to get along with others. In most cases the repression is successful and that is

the last we hear of it. But some cravings are not so easily vanquished, and they persist or recur to find a way of gaining their ends sometimes without our realizing it.

(1) *Mistakes in Speech and Action.* Freud pointed out that, strictly speaking, there are no "accidents." A young assistant in the laboratory wants the afternoon off to go fishing and "accidentally" breaks the apparatus. Barbed witticism vents our suppressed anger and relieves a tension. A young woman hearing that a sister-in-law whom she did not relish was to pass through her city wrote what was intended to be a cordial letter saying, "We will be delighted to see you on your way to Fremont." One's true feelings are thus often expressed. Read between the lines of what others say or write and you will often sense a repressed tendency that has slipped out.

(2) *Compulsions.* Many individuals feel an unexplained urge to perform a senseless act that gives relief. Among such acts reported by students are: touching posts as one passes by them, counting blocks or bricks in the sidewalk, lighting fires, keeping out of shadows of trees, counting electric light signs, tracing designs in a rug, jumping off high places, or drawing pictures while listening to a lecture. All of these actions have some value to the person who does them, though that value is not obvious. The value must be determined in each particular case. Recall in this connection the compulsion of Lady Macbeth who perpetually washed her hands to ease her feelings of guilt.

(3) *Forced Forgetting.* It is believed that repression is often followed by forgetting of things that would ordinarily be remembered. For example, a three-year-old girl once disobeyed her mother by climbing into a hayloft of the barn to look for hens' eggs. Having collected a few she slipped and fell down a ladder but was unhurt except for being smeared with eggs. A playmate helped remove the signs of her guilt and her mother did not discover her disobedience. Later, as a grown woman, she was entirely unable to recall the incident or even the barn, though both made a deep impression upon her and though other events and scenes of her childhood were recalled with relative ease, until a psychiatrist brought the memory to light. This is merely one of many

such anecdotes that show how the disowning of an act seems forcibly to prevent the recall of any memory of it and of things connected with it. There is little experimental evidence one way or the other on this point, but the weight of the proof seems to be in favor of forgetting by repression.

Substitute Gratifications. A frustrated motive often loses its irritating force if one goal or action is substituted for another.

(1) *Sublimation.* Many substitutions are socially acceptable and others are not. Unrequited love or parental drive may be partially satisfied by the adoption of pets, by teaching children, by nursing, or by philanthropic work. This does not mean, of course, that these activities are always prompted by thwarted love and parental motives. It merely means that they may be so activated. Socially worthy substitutes come under the heading of *sublimation.*

(2) *Phantasy.* Many a thwarted wish is gratified by a resort to daydreaming or phantasy. Imaginary fulfilment is almost as satisfactory to some people as real fulfilment. A young student one time was brought to the writer's attention because of being caught in a whole web of lies. Though poorly dressed, she claimed to be the daughter of a wealthy rancher in Texas who was highly educated and lived parts of the year in New York and Paris. He owned large, powerful motor cars. Her mother, she said, was dead. Asked why she was going to a middlewestern university, she said that her father had wanted to send her to an exclusive girls' school but that she was democratic and preferred a coeducational college. He had accordingly cut off her allowance and she was compelled to work her way. She boasted of her superior scholarship, but the records showed that she was about to be dropped from school for her low grades. Though she received letters calling her "Dear Sister," she claimed to be an only child and said that it was customary in her family to call close friends "Brother" and "Sister." The true facts were totally different. She was one of a poor family of 13 children. The mother was living but at that time was in a hospital for the insane. The father, instead of being a cultured and well-educated man, was almost illiterate. Instead of having several motor cars, he was about the

only farmer in his neighborhood without one. The girl had simply found her real world too hard to bear. She had invented one in phantasy that was more to her liking and she could explain away the inconsistencies to her own satisfaction, and, as she thought, to the satisfaction of her friends. She still kept enough of a contact with her school life to avoid being called insane, but the slender thread holding her to that much reality was very thin.

Daydreaming is a natural and a useful pastime, if kept within normal bounds. Daydreams lay down future lines of development for us; they make real and worth while our future goals. When substituted for some failures that we can do nothing about, they ease off many a tension. But when carried to the extent that they make us too contented with what we have, and when they prevent our making legitimate effort toward some real goal, then we should draw the line.

(3) *Identification.* We are encouraged and helped to achieve the substitute gratification in phantasy by means of the novel and the drama. The characters on the movie screen have the same trials and tribulations that we have. They have the things that we want but cannot have. We could not appreciate the story and the action if it were not possible to identify ourselves with the hero or heroine or with other desirable characters in the play. The author of the story and the producer of the play see to it that identification can take place and that tensions are sufficiently reduced. The demand for the happy ending is psychologically explainable and usually desirable. Only the few who obtain a sufficient gratification of their esthetic demands as such can go away satisfied with a tragic conclusion.

Identification does not end with literary models. Children identify themselves with parents and thus gain some of the strength they covet. Parents identify themselves with their children and, through this, often attempt to gratify old thwarted desires. A mother, much to her regret, married below her social class. She forces her children into being social climbers. A father always wanted to be a lawyer but circumstances forced him to be a farmer. He drives his son to drink trying to make him into a lawyer against his wishes and without regard for his abilities. Men

identify themselves with their fraternal organizations, their vocations, and with their home towns. Any fame that may come to those groups thus adds to their own self-esteem. In a crowd or a mob the weakling finds the strength he so dearly craves and there are enough others like him to feed the flames of hatred against the unlucky victim.

(4) *Compensation.* Compensations are typically associated with feelings of inferiority. Any felt failure serves to set the organism to work somehow to recoup its loss. The urge to make up for failures, to heal wounded pride, is usually stronger than the original thwarted desire and there is an overcompensation. A bodily organ does the same thing. A heart with a leaky valve grows larger and stronger than it needs to be in order to make up for its defect. If one kidney is removed the other enlarges to meet the new demands upon it.

Sometimes the effort to recoup self-feelings is exerted directly in overcoming the handicap itself. Theodore Roosevelt, sickly and nearsighted as a child, developed a robust physique, became a "Roughrider," a war hero, a wielder of the "big stick," a big game hunter, and as if that were not enough, he offered to lead an army in World War I. Another child, lacking in strength and vigor, becomes a roughneck and a desperado. Many a big, bold gangster may be hiding a quaking interior with an external shell of bluff and bravado. A noted Don Juan who boasted of many broken feminine hearts was found to be really effeminate and doubtful of his ability to play the masculine role, when he was once unmasked. Whenever anyone persistently overreacts in some respect, look for an underlying feeling of inferiority somewhere.

The man with the chronic inferiority complex shows it in various ways. He is usually sensitive or "touchy," he is on the lookout for signs of criticism, he continually compares himself and his accomplishments with others, he places a high value upon winning in competitive undertakings, but is careful to choose one in which he can win, and if lose he must, he is a poor loser and is ready with his alibis. It is doubtful whether a person with a confirmed inferiority feeling ever feels quite secure from criticism, no matter how great his accomplishments. In extreme cases

inferiority feelings lead either to the marks of genius, if there are sufficient talents, or to a nervous breakdown.

Defense Reactions. Defense implies protection from injury. In this case the individual attempts to maintain his self-esteem, not by extra effort to gain accomplishment and success, but by avoiding any appearance of failure. Failures are simply not recognized and they are hidden, if possible, from others. One's face is saved. There are many face-saving devices, but they conform to two or three types.

(1) *Projection.* By this device, the failure is disowned or it is minimized by finding the same failure in the other person. The child learns this trick very early. "Look what you made me do," is the usual expression. A girl, separated from her fiance for the summer, on their first meeting in the fall began accusing him of losing his love for her and wanting to break their engagement. He was stunned by the accusations. The correct interpretation finally dawned upon him; it was she who wanted her freedom. A husband who is untrue to his wife, much against his moral scruples, accuses her of receiving attentions from other men. How relieved we are to be able to shift blame upon the other fellow's shoulders!

In a study of projection in students, 97 subjects rated themselves and also some of their acquaintances upon such traits as stinginess, obstinacy, disorderliness, and bashfulness. Those who attributed little of these undesirable traits to themselves and much to others were generally rated by outside observers as having much of the same traits.[4]

(2) *Rationalization.* This means giving excuses for one's conduct instead of the real reasons when one slips below his social standards, or otherwise fails. The poor workman quarrels with his tools; the defeated athlete looks at his defective shoe; the disappointed suitor convinces himself that the girl "fell for the other fellow's money"; the candidate who did not get the job tells us that the winner "had a pull." The Phi Beta Kappa student may refer to the student-activities man as "one of those Babbitts," while the activities man refers to the Phi Beta Kappa as a "grind

and a dull fellow." All forms of alibis come under this heading. So do the so-called "sour grapes" reactions. No doubt some children are encouraged to make excuses for themselves as a form of relief. When the failure is of little real consequence a little rationalizing goes a long way to salve injured feelings. But when the cause of the failure is a personal weakness that should be changed, then the individual should face the criticism, be thankful for it, and try to make the needed change in himself if he can.

(3) *The Resort to Illness.* A little girl is given a stiff assignment for school tomorrow. She wakens on the morrow with dread and apprehension and a slight headache. The headache grows progressively worse. Her sympathetic mother lets her stay at home. Everything is lovely. But twenty years later what do we find? The same girl meets another distasteful assignment and by this time she has had further confirming lessons in how to avoid unpleasant duty and at the same time to avoid any blame from others or from herself. Many a hospital bed is occupied because such lessons were learned in the same seemingly harmless manner. Invalidism with all its apparent handicaps is often preferred to a more free existence with its bitter trials.

The proportion of apparently genuine organic disorders that stubbornly refuse to improve with treatment for the practicing physicians, that are methods of defense or escape created by the nervous system, must be very large. Dr. Karl Menninger cites the case of a woman who suffered an attack of boils every time she received word that her in-laws were about to come for a visit.[5] Many organic diseases, he maintains, are virtually attempts at suicide, which is always one way out. Not all these cases are genuine defense measures, for example, the woman's boils he regarded as a mode of self-punishment for resenting her relatives. But the point is that the control of the nervous system over the fate of the rest of the body is most remarkable. We have only begun to realize the possibilities of this control for good and for ill.

Regression. The normal urge of the child is to grow up. Assuming that nothing unusual prevents him from making the necessary changes in interests, in likes and dislikes, he reaches adult

age and to all appearances he is mentally an adult. Assume that he meets a severe jolt of some kind.

An example is a young woman known to the author. As an infant she was adopted into a home that was childless. Her foster parents literally adored her and her childhood was happy. On reaching womanhood she taught school for a time. Knowing that she was an adopted child she became curious to know what her real parents were like. Learning of their former whereabouts she made the long trip with the anticipation of seeing them. Upon arriving she found to her great consternation that her father was an inmate of a penitentiary and her mother was hopelessly insane. The shock was more than her nervous system could stand; she could not face the horrible truth. It was not long until she began to act and talk like a little girl. We say that she regressed or went back to an earlier level where life was sweeter and where she did not know the awful truth. She played with dolls, talked with a childish lisp, giggled, and acted the part of a child of ten. Some days she says she is twelve and some days that she is three. In either case her actions are in harmony with her adopted age.

There are other individuals who regress to the stage of infancy. They have to be fed, dressed, and cared for like an infant. Psychoanalysts believe that the regression may go back even to the prenatal stage, judging from the posture maintained by the individual.

There are numerous examples of more normal cases of regression which all of us show on occasions. One person when frustrated resorts to a "temper tantrum" such as he learned to use as a child but had presumably outgrown. Another person frequently delights in playing childish games and seems very much relieved afterward. An alumnus returning to his alma mater again becomes the undignified undergraduate, much to the amusement of his friends and of the students. The admonition "Be your age" is often needed to restore such people to adult actions. The poem beginning "Make me a child again just for tonight" is merely an expression of a desire that is rather universal and that lies at the basis of regression. Under the influence of intoxicating drugs there is usually a regression to earlier, outgrown modes of reaction due to the depression of the higher brain centers thus releasing lower "layers" or strata of behavior of earlier periods.

Dissociation. The outcome of a conflict in some persons is a splitting of the personality. The most common form is known as an attack of *amnesia.* A young husband and father finds his quarrelsome and poverty-ridden home beyond endurance and one day fails to come home. He turns up in a distant city not knowing how he got there or who he is. He may adopt a new name, and obtain a new job, but to him his past is a blank. His characteristics may be radically different from his former ones. If depressed and straightlaced before, he may become gay and carefree.

The term amnesia means forgetting, for the obvious reason that he forgets his past. But the deeper significance is that memory is the factor that unifies an individual and keeps him aware of his personal identity. Yesterday's experiences are knit together with today's and every other day's. In the split personality there has been a sharp cleavage. The old continuity is cut off and a new one is begun. There may be lapses into the old personality at times.

This is not the place to go fully into the subject of dual personalities. There is space only to point out that such abrupt cleavages in a personality are due to a conflict between very strong motives. The break keeps the two contending motives far apart; the tension is reduced.

Conversion Hysteria. Milder or less extensive dissociations also occur. The individual "disconnects" his seeing apparatus in some mysterious manner unknown to us and is functionally blind. Another disconnects his auditory apparatus and is for all practical purposes deaf. Still another loses sensitivity in an arm, a leg, a hand, or a forearm. In all these instances, medical examination fails to reveal any organic damage to nerve tissue or sense organs. Another class of functional disorders includes paralyses in different limbs or other parts of the body. The affected parts are useless and yet nothing is organically wrong.

All such disorders come under the heading of *conversion hysteria.* The explanation given by Freud is that a mental conflict becomes converted into a physical symptom. This is actually merely an expressive figure of speech. Actually, the steps by which the "conversion" takes place have never been observed or satisfactorily explained. It is true that analysis of the patient's life

will show reasonable correspondence between his conflict and the kind of symptoms he has. For example, a man whose dislike for his wife became so intense that he "hated the sight of her" went hysterically blind. A woman who worked as a domestic for a wealthy family met with a minor accident after which her leg felt numb. She soon developed a paralysis in the leg and sued the employer for a large sum of money. Medical examination proved that the paralysis was functional and not permanent.

The general conclusion is that back of every hysterical symptom is an ulterior motive or a conflict. It somehow "pays" the patient to be disabled, or promises to pay him; or he escapes from an intolerable situation by means of his disability.

Alcoholism. Relief from conflicts is often sought by resorting to drinking alcoholic intoxicants. There is a long-standing belief that many persons "drown their consciences in alcohol." This is one popular idea that has been scientifically vindicated. Alcohol is, indeed, an anesthetic to one's superego or conscience. When the anesthetic wears off, however, feelings of guilt and shame come back. They are intensified by added guilt and shame resulting from drunkenness and its personal and social effects. A vicious circle may thus be set up, ending in long periods of intoxication, or many "lost weekends."

The way in which alcohol acquires a compulsive attractiveness for the alcoholic has been demonstrated dramatically by Masserman. Masserman set up "experimental neuroses" in cats by subjecting them to severe conflicts in a manner somewhat as follows. After a cat had been trained to open a box to obtain food in response to certain light signals, he was one day given a severe electric shock at the moment he opened the food box to reach for the food. He violently withdrew from the food and on future occasions he showed various signs of neurosis or disorganized behavior. Some cats would go so far as to open the food box and then would "freeze" in that position. Others moaned and made jumpy movements. Others salivated copiously or vomited or shrank in a corner.

Before the experimental neurosis had been brought about, the cats uniformly refused to drink milk that contained alcohol.

After the neurosis had been induced, cats were forcibly given alcohol through tube feeding. Under the resulting intoxication a cat was relieved of his neurotic behavior and could again take food from the box without inhibitions. In other words, alcohol temporarily relieved him of his conflict. But the most interesting effect was found later when the cats that had been intoxicated were offered a choice of plain milk or of milk and alcohol. Half of the cats preferred the mixture and drank to the point of intoxication. Furthermore, they tended to lose their craving for alcohol after the neurosis had later been cured by other methods.

In every essential respect, the relation of alcohol and of craving for alcohol to conflict appears to be the same in cats and men. The human alcholic cannot expect an effective release from his abnormal craving until his conflicts have been cleared up sufficiently. Furthermore, the temporary relief afforded by alcohol seems hardly worth the risk of entering the vicious circle of alcoholism.

What to Do About Conflicts

The account of all the ways in which motives can enter into conflict and the ways in which the organism tries to reduce them to bearable terms can never be complete. Each individual is really unique, has his own unique desires and his own ways of meeting them and his own ways of reacting to failure. We can only point out some guiding lines which should help to understand a particular individual's own problems, for, after all, we are all built along similar lines, meet similar problems, and similarly succeed or fail.

Verbalizing the Desires. Space does not permit going into the various technical methods for diagnosing and treating conflicts. But in order not to leave the reader too much in the dark about what to do, one or two bits of advice may be given. The first is to encourage the person in trouble to verbalize his difficulty. Control depends upon this. No matter what approach a doctor or psychologist takes with his patient, this essential result is somehow accomplished. The psychoanalyst says that he brings repressed and forgotten memories from the unconscious up into the con-

scious mind. Essentially, he is giving the patient verbal expression to what before was inarticulate. From this it also follows that in order to prevent conflicts a child should be encouraged to put his desires and troubles into words. Too often, instead, he is hushed up and prevented from doing so. This advice does not mean that one should go around telling everyone about his inner life and his troubles. There is no surer way to bore people and no one except a real friend is particularly interested. We might sum up the advice of this paragraph in the cryptic words of that ancient wise man, Socrates: "Know thyself." No sounder psychological advice was ever given, but it must be applied with care. Half-knowledge, half-truths, and knowledge for which the individual is not ready may sometimes do more harm than good.

A Dependable Confessor Is Needed. Almost everyone needs someone in whom he can have the utmost confidence, a confidant who is willing to listen, a parent, an older brother or sister, a teacher, a doctor, a husband or wife, a minister, or priest. Talking itself yields some relief, probably because one is doing *something* in the direction of his goal of resolving the conflict. Confidence in the one whom we consult lends prestige to the beneficial suggestions that he gives. A danger to be avoided is that of developing too much dependence upon the "father confessor." And he in turn must forego the pleasure of his awareness of your dependence upon him. For really serious conflicts, the best advice is to see a competent psychologist or psychiatrist.

Some Rules for Mental Health. The following rules are proposed by the Cleveland Academy of Medicine. They are psychologically sound.

(1) Have a hobby; acquire pursuits which absorb your interests. Sports and "nature" are best.

(2) Develop a philosophy; adapt yourself to social and spiritual surroundings.

(3) Share your thoughts; cultivate companionship in thought and in feeling. Confide, confess, consult.

(4) Face your fears; analyze them; daylight dismisses ghosts.

(5) Balance fantasy with fact; dream, but also do; wish, but build; imagine, but ever face reality.

(6) Beware of alluring escapes; alcohols, opiates and barbitals may prove faithless friends.

(7) Exercise; walk, swim, golf; muscles need activity.

(8) Love, but love wisely.

(9) Don't become engulfed in a whirlpool of worries; call early for help. The doctor is ready for your rescue.

(10) Trust in Time; be patient and hopeful; Time is a great therapist.

Summary

Motives frequently clash in all of us. There are times when we would like to "have our cake and eat it too." Happy solutions are most often reached when the higher brain centers, particularly those involving the speech mechanisms, are brought into play. We are then more aware of the advantages and disadvantages on both sides of a question. The process is one of deliberation. But many times the conflict is partially or wholly unconscious, that is to say, it is kept below the verbal level of adjustment. We say then that irrational decisions are made, and individuals react emotionally.

Frequent sources of conflict lie in a person's failures. Inferiority feelings indicate thwarted desires for ascendance. Failure is a relative matter, however, depending upon how high his aspirations have been fixed.

Other common sources of conflict lie in a person's moral lapses to which he is sensitive and the resulting feelings of guilt. Mismanagement of a child's moral training leads to internal conflict if it has been over-strict and drastic, and to external conflict, perhaps delinquency and crime, if it has been understrict and lax.

Other sources of conflict lie in the love life of the individual; in his family attachments, self attachments, and unreasonably strong attachments for members of the same sex. The management of his sex urge is also often a factor for conflicts.

There are various standard ways in which conflicts may work themselves out, some of them as unsatisfactory as they are uncomfortable for the person concerned. Most queer, eccentric, and inadequate adjustments of an individual can be traced to his attempts to solve a conflict on an irrational, unconscious level

rather than on the conscious, verbal level. The correct approach is to attempt to make the individual aware of his faulty solutions and the contending factors that produced them, and to help him to find a more satisfactory adjustment. The aid of a psychologist or a psychiatrist is often desirable and necessary.

Questions

1. How much truth and how much error is there in the idea that every person has a subconscious or an unconscious mind?
2. What two distinct meanings of unconscious mental activities are recognized in this chapter? How do both meanings apply to motives?
3. Would it be desirable for an individual to grow up without having any conflicts, if possible? Why?
4. What is psychologically good and what is psychologically bad in the advice to "Hitch your wagon to a star"?
5. Should students be told their scores in psychological tests of abilities and traits? Discuss in the light of the facts mentioned under "level of aspiration" and "inferiority feelings."
6. Which has the worse consequences for a developing individual; to have too much or too little freedom of action; too much or too little moral training? Discuss.
7. How would you advise a person suffering from a conflict because he finds moral standards of his new community very different from those of his home?
8. Cite some examples of repression, of substitute gratification, or of defense reactions that you have observed. Classify the reactions under the appropriate categories of this chapter.
9. Find an account of a multiple personality and give a brief report of the circumstances, including symptoms and probable causes if they are known.
10. What advice would you give to a friend who is suffering unduly from an inferiority complex?
11. If you could, would you rid the world from inferiority complexes? If you did, what would be some of the important consequences?
12. What would be your advice to a person who suffers from alcoholism?

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CHAPTER VII

Emotional Responses

Every normal individual knows that he has emotions. Without emotions life would be dull, mechanical, and colorless. There are times, to be sure, when we would be very willing to do without the internal tensions and agonies. There are other times when we crave the thrill of excitement and cling to the joys of victory and success. Emotions seem such personal things that many people may dislike to see them dissected for the cool, observing eye of science. But that is precisely what we must now try to do.

It is very difficult to define the word "emotion." Almost everyone knows its meaning, and yet that meaning is hard to put into words. It is easier to define an emotional response. An emotional response is one that has three observable components: internal, or organic, reactions; expressive movements; and some variety of feeling tone. The feeling tone must be observed introspectively. In other persons we can only infer feeling tone from expressive movements that usually go with it. To say that an emotional response is merely one accompanied by organic reactions—rapid pulse, high blood pressure, inhibited digestion, and the like—is not quite correct. These changes often occur without emotion, as during vigorous, unemotional physical exercise. It is doubtful whether the felt emotion ever comes without some organic reactions, but it can occur with a minimum of expressive

movements. The expressive movements can come without the organic reactions or without the feeling tones that ordinarily accompany them, as in the accomplished actor who produces the motions but who may be otherwise "cold" emotionally. Some actors, it is true, actually feel the emotions they are portraying. The difference probably lies in the extent to which different parts of the brain are involved in the behavior of the moment.

Why Do We Have Emotions?

Some Typical Human Emotions. It takes several hundred words in the English langauge to name what we call emotional states. Here are a few: fear, terror, apprehension, rage, fury, suspicion, contempt, scorn, abhorrence, disgust, loathing, horror, dread, alarm, shame, remorse, awe, pity, gratitude, joy, and delight. These names apply to varieties of feelings we experience in ourselves and to responses observed in the other person. We are much more certain of the other person's emotion if we know the situation that aroused it. But the naming of the emotion in this case is based upon our own interpretation of the situation as fear-inspiring, loathsome, horrible, or awesome, and upon our own probable emotion were we in the other individual's place.

Emotions Are Related to Motives. Emotions are intimately connected with motivated behavior, for almost every fundamental motive that we can name has the name of some standard emotion corresponding to it; fighting—anger, escape—fear, sex—lust, maternal—tenderness are a few obvious examples. The correspondence is not always so simple and complete in everyday life, but it is generally true that emotional behavior is strongly motivated behavior, and the kind of emotion depends upon the kind of motivating factors of the moment. It is true, of course, that *all* behavior is motivated from within, as we have already seen. Unemotional responses are therefore motivated as well as emotional ones. We must therefore explain why some motivated responses do become emotional while others do not.

When Do We Become Emotional? There are a number of circumstances under which we become emotional. These circumstances can be described only in a general way:

(1) *When Motivation Is Strong.* It is a general rule that the stronger the motivation, the more likely is the response to become emotional. This has a distinct advantage, up to a certain point. Under emotional excitement the organism marshals its energy for additional effort. Heart and lungs are tuned to meet the additional demands about to be made upon them. The liver throws more sugar and other food material into the blood, ready for use. Many other changes that serve to make the striving more vigorous and effective are brought about. It would not be correct to say that the emotion you feel *causes* this internal organic preparation for vigorous action. The organic preparation is merely one segment of the entire emotional activity. As a result of this organic preparation, the individual is keyed up, alert, and his brain and muscles are able to act more efficiently. An individual in this condition usually has a feeling of power and some sense of mastery of the situation. Some people enjoy this state so much that they intentionally seek dangerous situations, or whip themselves into a mild state of anger just to experience the "lift" it gives them. The emotional mechanisms are probably doing their most for us if matters do not proceed any further than this. Unfortunately they often do.

(2) *When Motives Are Thwarted.* When a motive is moderately stimulating, and when the means of gratification are well learned and ready to function, and when there are no obstacles in the way, there is little emotion. In a dangerous situation, it is the man who cannot readily escape who is likely to become panic-stricken. Anger is more likely to surge to unusual heights when one cannot immediately strike his enemy. The first effect of thwarting, as we saw in a preceding chapter, is to stimulate greater motivation and to arouse more energy. This means greater emotional excitement.

When the excitement becomes too great, the reinforcing effect of the milder emotional state gives way to a disruption of behavior.

We "lose our heads," we "go to pieces." The reinforcing energy is too much for the otherwise well-organized patterns of response. We stutter, we strike out blindly, and we make other vigorous but ill-directed movements.

One thing that probably makes these disruptions so forceful and so out of place in human behavior is the fact that the reinforcing mechanisms were invented for the use of our remote ancestors. When frightened or angry they took to their heels or engaged in strenuous muscular combat. It is important, under such circumstances, to have some means of turning on a burst of organic preparation to meet the emergency. In modern civilized life we have the motives still, as did our remote ancestors. But our modes of escape and of fighting ordinarily require little muscular activity. Yet, the primitive organic preparations are still there and ready to operate when called upon. Not being discharged in muscular action, the excess energy serves merely as a disturber in general. Persons who are required to use this reinforcement in vigorous muscular activity probably show less disorganization in their behavior. They are not so likely to "lose their heads" unless there is real thwarting, and a consequent blocking of the use of the reinforcement.

(3) *When Motives Are Suddenly Removed.* Two occasions for the emotional reactions have already been mentioned. One is when a motive is intensely and suddenly aroused, so that no smooth-working mechanism is ready to proceed toward gratification. The brain is "hurried." Another is when there is a conflict, either from a thwarting obstacle in the situation, or from an antagonistic motive. A third case should be mentioned. When the need for gratification is suddenly withdrawn, when victory is suddenly and unexpectedly reached, there is joyfulness and jubilance. Another case when the necessity for striving is suddenly withdrawn may result in weeping, or grief, or in hysterical laughter. In a sense, the emotions coming under class three are negative to those in classes one and two, for they come with a sudden let-down of tension, whereas the others come with a sudden build-up of tension and need for striving.

The Development of Emotions

The Differentiation of Emotions. All attempts to classify emotions into neat categories have failed. The reasons will soon be made apparent. It might be expected that we should find the fundamental emotions in their purest form in young children, preferably in infants, before there is opportunity for training of the emotions. Observations of infants show, however, that the distinctions between different emotions are very hard to make. Months of careful observation of many children has led Dr. Bridges to conclude that the infant begins life with only one undifferentiated emotion which she calls, simply, "excitement."

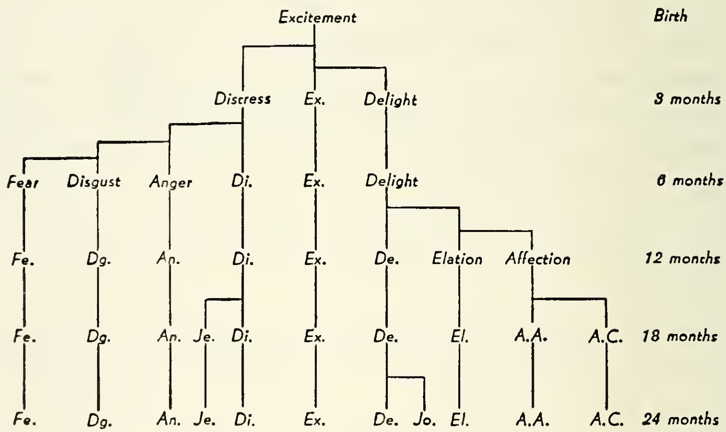

FIGURE 7.1 A diagram of the development of emotional reactions, showing how the different emotions become differentiated at various ages during infancy. Code: Je., jealousy; Jo., joy; A.A., affection for adults; A.C., affection for children. (After K. M. B. Bridges, from J. F. Dashiell, *Fundamentals of General Psychology*, Houghton Mifflin Company.)

At about three months one can observe a distinction between two special kinds of excitement that can be called "distress" and "delight." Further differentiations can be observed as shown in Fig. 7.1. Out of distress emerge anger, disgust, fear, and then jealousy. Out of delight emerge elation and affection, and later, joy. Whether the infant's own experience differentiates in a corresponding manner we do not know, but it is quite probable.

Further differentiations undoubtedly emerge from the parental stem as the nervous system matures and as new experiences are met.

Instinctive patterns of external expression, in face and posture, undoubtedly come by maturation, and account, in part, for the new variations. But learning also contributes its important share. One person's characteristic expression of fear or rage or love is never identical with the same expressions in another person. The internal, organic reactions, of heart, alimentary canal, liver, and glands, may also depend upon learning. One person's internal changes, during fright, are found to differ somewhat from another person's. The same person's expressions and internal adjustments during fear may differ somewhat from one situation to another, depending upon what he has learned to do about such situations.

Why It is Difficult to Classify Emotions. This is why it is so difficult to classify the emotions. When observed from the outside they are not by any means fixed quantities. Observed introspectively, they also vary, although there is probably a single core that is common to all anger experiences, another core common to all feelings of jealousy, and so on. This core is probably best identified in terms of the motive, or in terms of what we are set to do at the moment—to escape, or to fight, or to celebrate. Even so, rarely does any variety of emotion occur in its pure, unadulterated form. We find ourselves in a predicament, and the emotion is best described as a merger of fear, anger, and perhaps chagrin. Our team wins an important game, but a man is seriously injured, and our resulting emotion is a combination of elation and pride, tempered with grief. Even typical feelings of anger and fear are much alike, having many components in common, and the internal organic stir-up may be almost identical in the two cases.

Individual Differences in Emotionality. The susceptibility to emotional responses differs very much with the individual. Common sense recognizes that some are stolid or phlegmatic and even-tempered, while others are perpetually timid, or irritable, or warm-hearted. Difference in heredity is partly to blame, as Calvin Hall has demonstrated in the case of the white rat. The emotionality of an individual was measured by his proneness to "nervous" urination and defecation when placed in an exciting situation.

Selecting the most emotional and the least emotional individuals of one generation he tested the emotionality of their respective offspring. This was kept up for several generations, always choosing the most emotional of the one strain to become the parents of the next generation and choosing the least emotional of the other group to perpetuate its strain. The two strains of rats grew further and further apart in the emotionality test.[1]

Environmental factors also influence an individual's emotionality. Stratton discovered that persons who have had more childhood diseases, particularly below the age of six, are much more prone to anger and fear responses when tested at the college age.[2] An exception was that men with more childhood diseases were not more prone to fear. Stratton has also found a strong agreement between the strength of anger and the strength of fear in the same individual, as based upon his own ratings of strength. This helps to confirm emotionality as a general trait of individuals.

Expressive Components of Emotions

Among the expressive components are those adjustments that are observable to the outsider. These include: bodily posture, facial expressions, and vocal and musical expressions. By this we do not mean to imply that the individual has an emotion and then expresses it. The so-called "expressions" are part of the entire emotional reaction.

Darwin's Principle of Utility. After much study of emotional reactions in lower animals as well as in man, Darwin came to the conclusion that most expressions are useful to the individual, or if not now useful, they were useful to his ancestors. A fighting animal ruffles up its feathers, makes it hair stand on end, lashes its tail about, and bares its claws and its canine teeth. These measures frighten the enemy, make the individual harder to lay hold of, and prepare the weapons of defense for instant action. When angry, our hair does not stand on end, but we may feel "goose pimples," which are sensations aroused by the contractions of muscles in our skin that in our ancestors would have caused hair to stand erect. In sarcasm we sneer, baring our canine teeth. Incidentally, the

word "sarcasm" comes from Greek roots meaning, literally, to "tear the flesh." Our ancestors must have done just that.

Many emotional expressions did undoubtedly become fixed as inherited behavior patterns because they aided in survival of the individual and of the species. But Darwin should also have recognized that many expressions have a social value and have probably been retained for that reason. The expressions of smiling, frowning, and the like, inform others of our attitudes but probably never had any survival value of the kind that Darwin had in mind.

Bodily Posture. This depends so much upon what the individual is going to do about the particular situation that it bears little constant correlation with the emotion one feels. There are some exceptions, however. We can think of being bowed in grief, in reverence, or in submission; of stiffening in anger; of slumping in defeat; or of leaning forward with expectant attention. These are but a few dependable, emotional postures.

The Startle Pattern. One of the most dependable patterns is the startle response. By means of ultrarapid motion pictures, Hunt and Landis have been able to catch the entire course of this pattern in response to a pistol shot.[3] The entire reaction is over in from .3 to 1.5 seconds. The reaction begins in the head and proceeds downward. The eyes close (in about 40 milliseconds after the shot), the face goes into a contortion (at about 100 milliseconds), head twists forward, shoulders hunch forward (at about 140 milliseconds), arms rotate slightly, elbows bend, fists clench slightly, trunk bends forward at the waist, the abdomen contracts, knees bend slightly (at about 345 milliseconds), and the feet shift slightly on the floor. The pattern is so consistent in different individuals that it is undoubtedly an inherited one. It is also found in the higher apes.[4] In the infant it does not appear until about the fourth or fifth month.[5]

Facial Expressions. The human face is one of the most expressive instruments of the individual. It is richly supplied with muscles in the forehead, around the eyes, nose and mouth. There is much individual difference in the use of these muscles and in the patterns going with each emotion. But there is a rather

conventionalized "language" of the face to which most people can agree. The elements of this langauge are somewhat as follows:

The Forehead and Brow. Here we find two elements. The brow can be raised, producing an arched brow and horizontal wrinkles in the forehead. The effect is of some form of surprise, amazement, or astonishment. The brows can be contracted, producing vertical wrinkles between the brows. The effect is one of unpleasantness or of effort. The two elements can occur in different degrees, or they can occur in combination, giving a variety of effects.

The Eyes. We watch the eyes of another person primarily to find a clue as to his attention. Wide-open eyes mean great visual attention, as in interest, fear, horror, or terror. Eyes turned upward imply submission to a higher power, pleading or supplication; turned downward they imply inattention to the environment for any of a number of reasons. The narrowed eye is traditionally associated with suspicion, but one could hardly depend upon this. The closed or averted eye may also indicate inattention.

The Nose. The nose contributes little to facial expression. It can tilt upward and narrow the nostrils, as if to close them against bad-smelling stimuli, or it can open them widely, as in preparation for more effective breathing in strong motor activity.

The Mouth. The mouth, of all facial organs, has the greatest variety of expressions. Some of them, as Wundt pointed out, seem correlated with the sense of taste. There is what he called the "sweet mouth," a pursing of the lips, as if to hold a sweet morsel at the tip of the tongue where it can be tasted best. There is the "bitter mouth," with lower lip curled downward, perhaps with tongue protruding, as if expelling a bitter substance from the back of the tongue, where it is tasted most strongly. There is the "sour mouth," with the corners of the mouth pulled down, as if to let sour substances roll off the sides of the tongue, where we are most sensitive to sour. There is no "salty" expression, which is correlated with the fact that one part of the tongue is about as sensitive to salt as any other.

There is the "determined" mouth, with its set, straight, and thin lips, that goes with the clenched jaw, when we exert effort. There are the laughing mouth and the smiling mouth, and the snarling or sneering mouth with upper lip curled to expose one or both of the canine teeth. There is the open mouth of great attention, and the open mouth for better breathing, when we engage in strenuous physical activity. The contributions of each part are suggested by the facial model in Fig. 7.2. By means of this model, various component expressions can be combined.

FIGURE 7.2 A facial model by which it is possible to combine component expressions of brows, eyes, nose, and mouth, to produce many conventional total expressions. (After J. P. Guilford and M. Wilke.)

The Voice. That the voice often conveys emotional tones is a well-known fact. Just how much is expressed in the voice alone, however, can be determined only by making scientific tests. And what factors in the voice are responsible for the impressions that it gives of the emotional state of the speaker or singer also require scientific investigation.

The speaking voice is undoubtedly much freer to express shadings of emotion than the singing voice, since it need not follow pitches and rhythms imposed upon it by the musical score. It can also take on harsh and noisy qualities when needed. Orators and actors make most effective use of the voice, in addition to the words they utter. Changes in pitch, loudness, inflections, stops, starts, glides, and other factors contribute their effects. A single tone can be uttered or sung in various ways to suggest surprise,

fear, pain, sorrow, anger, and hate. Sorrow, anger, and hate are most easily expressed in this manner. Think in how many ways the simple word "Oh" can be uttered to convey different effects. Psychologists have recorded the speaking and singing voices of actors and singers, and have analyzed them to see just what factors are used in the artistic expression of emotion by the voice. Fig. 7.3 is an example of this type of record.

Speech. Speech is the most complicated and delicate of mental activities. The disruptive effect of emotions is consequently most

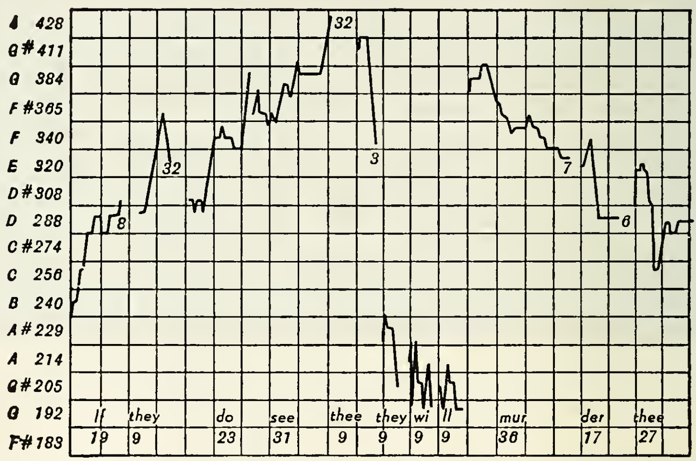

FIGURE 7.3 Changes in pitch of the speaking voice during emotional expression. A part of Julia Marlow's rendition of Portia's speech in "The Merchant of Venice." (After G. M. Merry, from R. S. Woodworth, *Psychology*, Henry Holt and Company, Inc.)

apparent in this activity. Stammering, stuttering, blocking, even paralysis of speech, are all too common in this connection to require comment.

The Word-Association Test. A systematic way of exploring the emotional life of an individual is to give him the *word-association* test. In this test the subject is told that for each stimulus word he is to respond with the first single word that he thinks of as quickly as he can. An emotional response, even though very slight, to any of the stimulus words, is shown in various ways. The chief value of the test is that, for the human subject, words are

substitutes for real things. A mild emotional response to a word suggests a stronger emotional response attached to the thing that it signifies. By this method unconscious, emotional conflicts can often be uncovered. Notice the two lists of words in Table 7.1, for example. One is ordinarily an emotional list for young people, the other is not. The numbers after the words give the average extent of the *psychogalvanic response,* which may be taken to indicate the amount of excitement aroused by each word.

TABLE 7.1.—LIST OF STIMULUS WORDS OFTEN USED IN THE WORD-ASSOCIATION TEST *

Unemotional Words	*Galvanic Response*	*Emotional Words*	*Galvanic Response*
swim	14.2	kiss	72.8
pencil	15.4	love	59.5
pond	15.5	marry	58.5
flower	16.1	wound	38.0
give	16.7	afraid	36.8
glass	17.6	proud	36.7
white	17.8	habit	36.6
hunger	17.9	money	35.6
bury	18.0	fight	35.0
carrot	18.2	despise	34.7

* Adapted from Smith.[6]

Indicators of Emotional Word Reactions. There are a number of signs of emotional disruption in the subject's word reactions in the association test. Some of the more important ones follow:

(1) *Prolonged Reaction Time.* Emotional responses often paralyze action. The typical, unemotional word reaction requires from 1 to 2 seconds. Some reactions to emotional words are delayed 5 to 10 seconds. Sometimes the subject checks his first response, which he realizes is socially taboo or humiliating to him, and therefore must wait for a better one to come. At other times his mind, he says, is just blank; the blocking is unconscious.

(2) *Failure to Respond.* The delay may be so long that it is regarded as a real failure to respond.

(3) *Repetition of a Former Response.* The same response word may come two or more times. This may be an evasive device, or it may be forced by some urgent conflict that is bothering the

subject. One boy aged 11 gave the response "stomach" eleven times in a list of 100 reactions. He had certain fears about his stomach.

(4) *Personal Responses.* The connection between stimulus and response may be peculiar to the individual himself rather than to some common logical association that we would expect from a subject of his education and background.

(5) *Overt Emotional Signs.* Such incidental actions as blushing, clearing the throat, shifting uneasily and the like, may be used, though with caution, as indicators.

Detection of Guilt by Word Associations. An individual who has recently committed a crime and has a "guilt complex" because of it can often be detected by means of word-association tests. Some stimulus words connected with the crime are chosen, mixed with "control" words of an unemotional type. Several suspects are given the same test, and, using all available complex indicators, the guilt can often be placed. The method will work only under very favorable conditions and is not adaptable for general use in criminal courts. Crosland has had remarkable success with students as subjects. In connection with seven petty crimes, five of stealing, one of cheating, and one of forgery, 55 persons were tested. Confessions vindicated the method in all but one case.[7]

Expression in Music. In spite of the common belief that music can convey very specific emotions, it is actually unable to do so. The response to music is surely emotional; this cannot be doubted. But its effects are very general and vague and hard to name, and they vary a great deal with the individual listener and his mood. Hevner has found that, in general, the major keys are described as happy, merry, and the like, whereas the minor keys are sad, dreamy, and sentimental. Firm rhythms are described as vigorous and dignified, whereas flowing rhythms are dreamy and tender. Complex harmonies may be exciting, vigorous, and sad, while simple harmonies are happy, serene, or lyrical.[8] Compositions intended to arouse particular emotions may fall far short of that goal. Rigg finds that even the easiest distinction to make, that between the sad and the joyful, is judged correctly by only 73 per cent of the students, and those with musical training do no better than others.[9]

Organic Components

The Autonomic Nervous System.—The organic reactions associated with your emotions are controlled through the autonomic system. A diagram of this system is shown in Fig. 7.4.

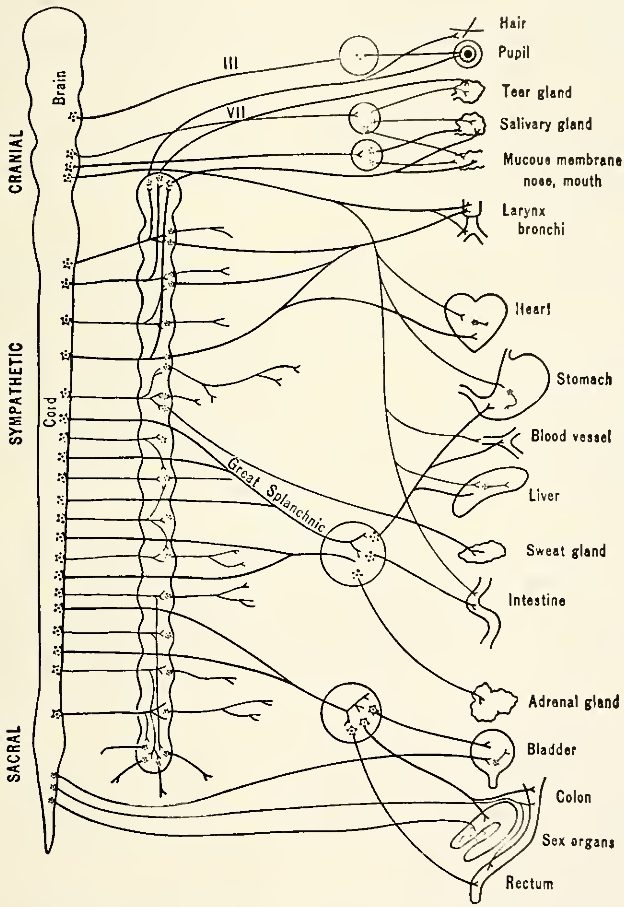

Figure 7.4 Diagram of the autonomic nervous system and the bodily organs excited and inhibited by it. (Adapted from W. B. Cannon.)

It receives its excitations from the central system, directly from centers in the hypothalamus and the brain stem. In the brain of the cat, for example, there is a definite place in the hypothalamus that, when excited, throws the cat into a rage, with all the

pattern of fighting thrown into gear and all the organic stir-up. This can happen when the cerebrum is entirely removed. The rage center, and other emotional centers, receive their excitations either directly from sensory impulses or by way of the cerbral cortex. For example, we may react emotionally to loud sounds, painful stimuli, and other elemental exciting stimuli without the aid of the cerebral cortex. Generally, the objects and situations that arouse emotions are complex, which means that emotions are usually incited through the cerebral cortex. A cat's rage without the cortex being present is stereotyped and is directed at no object in particular. It ends abruptly. It is an incomplete or "sham" rage.

While the emotional responses, such as fear and anger, are probably innate or unlearned, we have to learn, for the most part, of what to be afraid and toward what to be angry. Learning is a matter of cortical action. We also learn to prevent some of the expressive components of emotional reaction. The cerebral cortex, then, is both an instigator of emotional reactions and an inhibitor of some of their components. Complete inhibition of emotion probably means failure to instigate it.

The Sympathetic and Parasympathetic Systems. In Fig. 7.4 note that there are three divisions of the autonomic system. The central part is called the sympathetic system, and the upper and lower, together, the parasympathetic system. Both systems send impulses to most bodily organs, and, in most cases, their effects are just the opposite. The parasympathetic system promotes the general functions of nutrition and reproduction and the general business of living. The sympathetic system is known as an "emergency" system. It is fire department, standing army, and riot squad all rolled into one. When emergencies are met in the environment, when extra energy is called for, this system is immediately alert, and goes into action. In its mobilization for action it usually puts a damper on the digestive functions and other functions that may detract from the urgent business at hand. In most of the exciting emotions, fear, anger, acute suffering, and even in unemotional physical exercise, about the same patterns of bodily changes occur. So, while we can say that if there is an exciting emotion we should find these organic preparations for action,

we cannot say that whenever those organic changes occur we can expect an emotion. Let us see what some of the changes are when exciting emotions do occur.

Some Organic Reactions during Exciting Emotions. Some of these changes are muscular, involving the heart and the circulation of the blood, breathing, and contractions of the alimentary canal. Some involve glandular secretions, and others involve chemical changes in the blood.

Changes in Circulation. During excitement the heart increases the rate of circulation by a more rapid pulse and by a greater amplitude of each pulse beat. The two do not always increase together. A startling stimulus may first cause a weak, rapid pulse for a moment, and then a strong, rapid pulse for a while, or it may cause a strong but slow rate.

Another muscular change affecting circulation is the contraction or relaxation of the very small muscles in the walls of the arteries. Sympathetic stimulation causes constriction of arteries in the viscera, thus forcing blood to the external muscles and raising the blood pressure. The blood pressure is also raised by a stronger pulse. Highly emotional individuals, who live under great tension, send their blood pressure up and keep it at a high level. The pace of modern living is responsible for many an early death from overworked arteries. Emotional strain at the time a blood-pressure test is taken often gives a false impression of the usual blood pressure of the patient.

Changes in Breathing. Emotions disrupt the regular breathing rhythm in various ways. Excitement may increase both rate and depth of breathing, depending upon the kind of activity to be engaged in. Startling stimuli check breathing momentarily; then it increases. Grief, depression, and conflicts tend to lower the amplitude of breathing, which must be compensated for by occasional deep sighs. Continuously disturbing stimuli usually result in irregularity of rhythm.

Fig. 7.5 shows a typical record of changes in breathing and in pulse and blood pressure in a young woman during a laboratory experiment. When the stimulus words "kiss," her first name, and "God," were spoken, the pulse grew weaker, the blood pressure

rose abruptly followed by a stronger pulse. Breathing was halted almost completely for a moment.

Changes in the Alimentary Canal. Sympathetic excitement checks the normal process of digestion. The flow of saliva is inhibited. That is why a frightened speaker suffers from a dry mouth, and his tongue may feel like a block of wood. There is said to be an old Chinese custom that is based upon this salivary reaction. In a criminal trial, several suspects were brought together and each was given a handful of uncooked rice to hold in his mouth while being accused of the crime. After a few moments the rice was removed and examined. Unfortunate was he for whom the rice remained dry, for he was the one judged guilty.

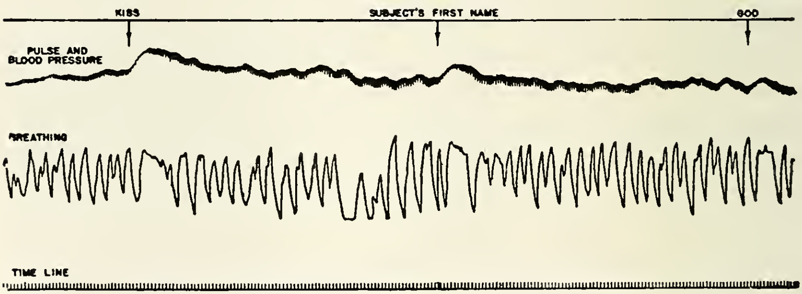

FIGURE 7.5 Records of heart action and breathing during emotional responses to stimulus words. The change in heart action is a temporary weakening of the pulse followed by a stronger pulse beat, with a sharp rise in blood pressure. Breathing is interrupted at the stage of exhalation and made irregular for a short time. (Courtesy of W. E. Walton.)

Gastric juices and other secretions tend to stop flowing. The rhythmical contractions of the stomach come to a halt, and this may persist for some minutes after the emotional shock, as can be seen with X-ray observation. For these reasons one should not eat a meal when upset, greatly fatigued or excited.

The intestines, including the colon and rectum, also undergo disturbances during emotional excitement. There may be increased activity or decreased activity. There may be constipation or diarrhea, depending upon the type of exciting situation, the emotional habits of the individual, and the severity and duration of the emotional upset.

Glandular Responses. Stimulated by the sympathetic nerves, the adrenal glands, situated on top of the kidneys, send more adrenalin into the blood stream. *Adrenalin* serves to sustain the changes already brought about by the sympathetic system itself. It has some help in this, for the sympathetic nerves also stimulate the secretion of a chemical, called *sympathin,* at the ends of the nerves. This tends to keep the organism often unnecessarily in a prolonged state of excitement long after the urgent situation has passed.

Besides keeping the heart working harder and faster, the breathing more efficient, and the digestion inhibited, adrenalin causes the liver to throw more sugar into the blood, feelings of fatigue to disappear, and the individual to feel stronger. Seemingly superhuman feats of strength and endurance have been performed under the influence of adrenalin. The blood clots more easily, in case of injury. During emotional excitement the blood also becomes more dense, shows an increased number of red and white cells, and contains more protein and fatty food material as well as sugar.

The Psychogalvanic Response. A glandular response of particular interest is the *psychogalvanic response.** If two electrodes are attached to the skin of the hand, and a small amount of electric current is sent through them, the hand will conduct some current, but being a poor conductor the resistance, as measured in ohms, is very high. With a delicate galvanometer in the circuit one can measure the very slight changes in resistance that take place from moment to moment. It has been known for a long time that exciting stimuli will cause a lowering of resistance, that is, the hand becomes a better conductor. The secret is now believed to lie in the secretion of the sweat glands.

The best place to obtain this reaction is from the palm of the hand, for perspiration anywhere else, except the sole of the foot, seems to be merely a temperature-regulating device. The galvanic response will occur elsewhere on the skin when, because of muscular activity, or for other reasons, it is necessary to cool the body. Perspiration on the palms of the hands and the soles of the feet has the biological effect of making them better able to cling to

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* Also often called the *galvanic skin response.*

objects during emergencies. Thus, at these locations, we can get a delicate indicator of emotional excitement. The excitement may be so slight that the individual feels no emotion, and yet the galvanic response occurs. On the other hand, there may be unexciting emotions without any galvanic response; thus, the two things, galvanic response and felt emotion, are not by any means perfectly correlated. Fig. 7.6 shows the changes in skin resistance of a student while watching a thrilling wild-west cinema.

The reaction of perspiring in the palm of the hand during a strong emotional reaction is clearly demonstrated by a certain

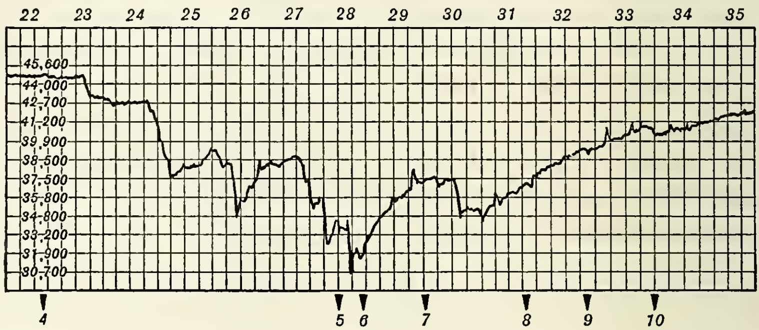

FIGURE 7.6 Continuous record of the skin resistance of a subject who was watching an exciting wild-west motion picture. The lowest part of the curve comes during a sequence of pursuit and capture. The hero overtakes the villain at 27 minutes; they clinch, fall off their horses, and roll down a steep embankment at 28. The fight ends after 30. (After D. U. Greenwald, from C. A. Ruckmick, *Psychology of Feeling and Emotion,* McGraw-Hill Book Company, Inc.)

young woman who was once the victim of a terrifying experience. With a girl friend she was engaged in mountain climbing one day, when the two suddenly lost their footing. They clung precariously over a cliff several hundred feet high and were at the point of exhaustion when rescued many long minutes later. To this day, after merely telling about the incident, the young woman's palms become dripping wet with beads of perspiration. The galvanometer is a delicate indicator of much milder degrees of the same reaction.

The Lie Detector. The typical lie detector makes use of changes in heart action, in breathing, and, sometimes, the psychogalvanic response, as indicators of emotional excitement in the

liar. Most of those responses are beyond voluntary control in all except the rarest individuals. Before the test, the suspect is given a brief lecture to put him in the proper frame of mind. A list of questions is prepared beforehand, beginning with harmless ones like "Did you have breakfast this morning?" or "What day of the week is this?" Then suddenly comes a crucial question, "Did you rob the Sapphire Jewelry Store?" Then following this may be the question, "Did you lie to the last question?" All possible signs of emotion must be taken into account and carefully interpreted. With the proper controls, and in the hands of experts, the test has a high score of validity to its credit.

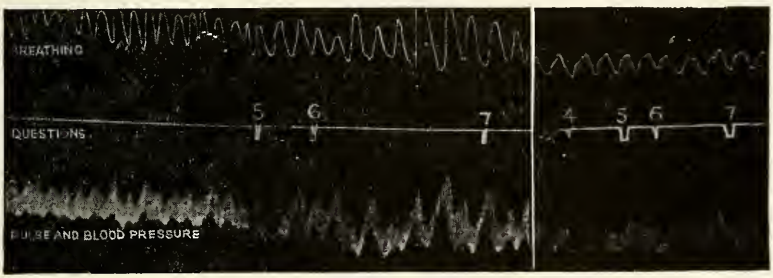

FIGURE 7.7. A part of a record obtained from a lie detector. The breathing curve is shown at the top and the pulse and blood-pressure record at the bottom. The line in the middle row registers the points at which certain questions were asked. Up to question 5 breathing and blood pressure were normal. After the crucial questions 5 and 6, breathing became shallow and then irregular, and blood pressure fluctuated sharply. After confession of guilt, the test was repeated. The shallow breathing, low pulse, and steady blood pressure at the right go with the relief and relaxation after confessing. (After J. A. Larson, courtesy of the *Journal of Experimental Psychology*.)

It is not infallible, but it is a valuable addition to the tools of crime detection. Fig. 7.7 shows an early record taken from an actual criminal case. After confessing, the suspect shows signs of reduced tension, in the low pulse and blood pressure and regular breathing.

Psychosomatic Disorders. In recent years we have heard a great deal about "psychosomatic medicine." This field grew out of a realization that a very large percentage of human physical ailments are of mental origin. Headaches, neck pains, backaches, and nausea are often symptoms of mental conflict rather than of

any organic injury or damage. Stomach ulcers and ulcers of the intestinal tract, mucous colitis, much of asthma affliction, and some allergies can be traced to prolonged and repeated emotional excitement due to some conflict.

Any threat to one's life or love, or a blocking of the usual fulfillment of one's cravings causes some individuals to react as if to a catastrophe. An elderly man, alone in the world, suddenly loses his savings or his pension. A young man is continually nagged by his wife and his mother because he does not "get ahead" as they think he should. A wife is repeatedly embarrassed by her husband's infidelities but she still loves him and has kept the family together for the sake of the children. Organic emotional reactions were intended to operate briefly and on somewhat rare occasions. People with a conflict keep the organic disturbances going or repeatedly stir them up. Every time the individual is reminded of his plight, his panic returns. In time, the affected tissues may suffer permanent damage.

That is what happens in the case of stomach ulcers. The individual reacts to some situation as if it were a vital assault. He becomes angry. He carries around with him a state of resentment, hostility, or hate. Under this condition it is known that for some reason not well understood, the stomach prepares for eating. The lining becomes engorged with blood, secretions become more acid, and the muscles contract. The result may be in the form of small hemorrhages which leave openings that are vulnerable to attack by outside forces. Digestive acids start to digest stomach tissue itself. This may lead to feelings of distress, adding to the stimulation of emotional reactions, thus setting up a vicious circle. This is the way that stomach ulcers are believed to be formed. The patient can probably expect no permanent cure unless his conflict is cleared up. An old Albanian merchant expressed it by saying, "Business good—stomach good; business bad—stomach bad."

Continued and repeated threats that stir up more fear than anger are likely to cause engorgement of mucosa in the nasal passages or disturbances of breathing. Under the tensions of anxiety, muscular contractions occur here and there, perhaps with the intensity of spasms. Local pains are thus produced and they are interpreted by the victim as injury and lameness. A pain in

the chest region is interpreted as a heart attack. This in turn arouses fear of greater agony to come and of sudden death. Thus, another type of vicious circle has been set up. Close attention is given to the heart beat and it is noted that the pulse is irregular, even skipping a beat now and then. If the individual happens to be looking for excuses for failure, or some avenue of escape from unpleasant duty or from unwanted responsibility, at the time, he may welcome the symptoms, while at the same time he fears them. In such manner are neurotics developed. Medical waiting rooms and many hospital beds are heavily populated with such as these.

Control of Emotional Reactions

Everyone probably wishes at times that he had better control over his emotions. It may be because he wants to conceal his emotions, as in playing a competitive game like poker. It may be because he wants to be less emotional to save himself some suffering and its aftereffects. Or it may be to prevent his "going to pieces," which later makes him ashamed of himself and which at the time makes his management of the situation very ineffective.

Development of Emotional Control. Very young children naturally give full and uncontrolled vent to the expression of their emotions. In the process of socialization, pressure from others causes them ordinarily to curb the more violent expressions. Control over external expressions does not, unfortunately, also carry with it inhibitions of internal organic reactions. In fact, there is good evidence that the internal components may become intensified as external expressions are brought under control. This is true of the psychogalvanic response, at least, which is low or absent in very young children and becomes stronger with increasing age. Among older children, too, there is a *negative* correlation between amount of overt emotional expression and amount of psychogalvanic response. That is, individuals with much overt expression are likely to have little psychogalvanic response and vice versa. If this is also true of organic responses of the alimentary tract and of the respiratory apparatus, it gives us pause to wonder

whether too much control of external expressions is a good thing. It may well be that persons who do allow more overt response thus work off excess emotional tension and thereby save themselves from possible psychosomatic disorders.

Society will not tolerate such violent expressions as tantrums, however. Anyone who continues to show such lack of self-control beyond early childhood is regarded as emotionally infantile. If he is an adult, he is regarded as emotionally immature. Immaturity is also shown by the persistence of childhood fears that should have been outgrown and by over-dependence upon parents. It is also shown by lack of tolerance to minor frustrations, as in the adult who must have what he wants when he wants it.

Emotional maturity is a matter of learning or habit formation. A full discussion of how to develop emotional control cannot be given without bringing in principles of learning, which are treated in later chapters. Here, however, we can consider what we know about emotional behavior as a basis for stating some simple general rules. The essential facts to be considered are, briefly: (1) the troublesome emotions are a consequence of strong, urgent, and demanding motivation (out of proportion to the individual's readiness to progress toward the goal); (2) emotional components of a response are released only when the cerebral cortex has given an interpretation of a situation that calls for them (the situation is threatening to one's well-being, if not to his life); and (3) most overt expressional components can be brought under voluntary control but most organic components cannot.

A Few Rules About Emotional Control. In any particular situation it would be desirable first to analyze the situation to see what measures of control seem most appropriate. The following rules are merely general suggestions of measures that will work when properly applied.

1. *Avoid emotion-provoking situations.* If we lack stimuli that arouse emotional responses we will not have them. If a child is over-wrought from harrowing stories, exciting movies or television, he should be exposed to these in small, tolerable doses. If a certain city environment is a perpetual reminder of loss of a

loved one or of a critical defeat, a move to another city will help. One should decide, however, whether such a move is merely running away from a situation that would better be faced. Running away may arouse feelings of shame and regret that would be just as damaging emotionally as staying and facing the stimulation.

2. *Change the emotion-provoking situation.* Perhaps it is within your power to change the situation so that it is no longer a source of devastating stimulation. This may involve the removal of certain persons by some method (short of murder), or changing their attitudes, or making friends out of enemies.

3. *Increase skills for coping with the situation.* As was said before, much emotion comes from inability to achieve desired goals as promptly or as rapidly as one wishes. This may be remedied by developing the necessary skills to cope with the situation. Often it is lack of social skills in dealing with people. Some children have been sheltered so thoroughly by well-meaning parents that they are forever behind in keeping up with their associates in the ordinary give and take of daily living. They may withdraw from the competition, which puts them further behind. Systematic practice in the arts of conversation, social dancing, and other social activities will do much to build up confidence and to prepare for the management of situations in a self-respecting manner.

4. *Re-interpret the situation.* Many fear and rage responses are entirely unnecessary because situations are grossly misinterpreted. Hypersensitive people, usually those with inferiority feelings for some reason, are perpetually tuned to stimuli that hurt their egos. They read insults into statements where none were intended. They "make mountains out of molehills." Small, unintentional slights are taken as dire threats to their already shaky status.

Even when the situation is actually threatening, it pays to take the time to analyze it to get a clearer idea of what it actually means. The threatening individual may himself be of the insecure, inferiority-feeling-ridden type. Why is he behaving the way he does? Can you do anything to ease *his* feelings of inferiority? What is he trying to accomplish? Can you help him achieve his goal and

would this cost you less than an emotional blowup would cost you? Two quarreling mates or lovers might well stop and ask themselves just why they are quarreling. What brought them to the state of war? What does the other person really want?

5. *Keep working toward your goal.* Every emotion-provoking situation presents you with a problem. It will help to think of it as a problem to be solved, and to proceed to find the means of solving it. Even a few wrong steps, if they seem to be in the right direction, offer temporary respite from emotional involvement. Solving a problem is largely a matter of trial and error. We try one thing after another or we think of one thing to do after another. If you do not engage in such steps toward the solution, your viscera will try to help by doing one thing after another, in other words, organic components of emotional responses. These reactions never solve a problem. They need not occur if progress elsewhere is evident.

6. *Find substitute outlets.* Achieving substitute goals may help. At least they give temporary relief. If they do not solve the problem or make it less acute, however, they are merely palliatives.

7. *Develop a sense of humor.* One of the best substitute outlets is in the form of laughter. A threatening situation that really should not be threatening may become trivial if one can see its humorous aspects. The reason many persons are so vulnerable to threats is that they take themselves too seriously. Such a person sometimes sets standards for himself, vocational, social, or moral, that are entirely unrealistic for him. He should realize that no one can be perfect in all respects. When he fails, in some respects, as everyone inevitably must, he should be able to laugh at himself along with the rest.

Summary

Emotional responses involve three aspects or components: organic reactions, external expressions, and felt experiences that characteristically go along with those muscular and glandular reactions.

We become emotional under a number of circumstances, all having to do with motivation: when a motive is too suddenly or vigorously aroused, when we are thwarted in attempting to gratify a motive, or when the need for gratification of a motive is suddenly removed.

Emotional responses develop in the infant and child by having new, more specific patterns differentiating out of an original, general, excited condition. Most emotional responses continue to show their relationships, the excited emotions retaining many components in common in the adult. Individuals develop characteristic differences in the ease with which exciting emotions can be aroused.

The expressive components of emotions can be seen in various bodily adjustments; bodily posture, facial expression, voice, music, and speech. Speech, being one of the most delicate of motor patterns, is most easily disrupted when exciting emotions arise.

The organic components of exciting emotions serve as a general tuning-up process for muscular exertion. In our ancestors, from whom muscular exertion was more frquently required, this organic preparation was of great value. In modern civilized life it is often merely disturbing and disrupting. The nervous mechanism for the organic reactions is the autonomic system, with its source of excitation in the brain. The sympathetic division goes into vigorous action for all exciting emotions. Changes in breathing, in circulation and composition of the blood are some of the more obvious organic preparations. Inhibition of the digestive and nutritive processes along the alimentary tract is another common result of sympathetic excitation. Another sympathetic response is detected by means of the galvanometer, on the skin of the palm of the hand, in particular. The instrument known as the lie detector makes use of the more dependable indicators of exciting emotions.

Prolonged or repeated emotional upsets are known to produce such psychosomatic disorders as asthma, colitis, allergies, and ulcers of the gastrointestinal tract.

Control of one's emotions means either a prevention of their occurrence or a curbing of their expression. Restrictions placed upon the child in his social groups usually teach him to reduce

the outward signs of emotion, but they do not also prevent inward, organic effects. Prevention of emotional reactions in the adult depend largely upon controlling emotion-arousing situations or the interpretation of those situations. It also depends upon better preparation for meeting situations and finding substitute outlets, such as laughter.

Questions

1. Why are particular emotional expressions more easily observed in adults than in infants, and in posed than in unposed photographs?
2. Mix up the two lists of words given in Table 7.1, and apply them as stimulus words in a word-association test to another young person. Note as many signs of emotional disturbance as you can. Compare the two lists of words as to frequency of emotional responses.
3. Find and read a popular article on the lie detector. What conclusions can you draw from it as to the validity of the lie detector described?
4. Why do many people believe that music gives rise to definite emotional responses? Why does it fail to do so?
5. Write a short essay upon the effects of emotions upon bodily health. Do you know of any individuals who seem to suffer physically from emotional stress? Describe a case.
6. In a lawsuit, is a jury ever justified in according damages to a plaintiff who claims harmful effects from emotional stress caused by the defendant? Justify your answer.
7. Why is it important for the average doctor to be familiar with the psychology of emotions? Give a number of reasons.

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CHAPTER VIII

Likes, Interests, and Attitudes

Most motives, if not all of them, can be divided into two groups, positive and negative. Some are cravings and some are aversions. The result is that some stimuli are sought after and others are avoided or rejected. It is this double tendency to be attracted or repelled by stimuli that we are to examine next.

Likes and Dislikes

Pleasantness and Unpleasantness. Most stimuli affect us at the moment as being either pleasant or unpleasant, agreeable or disagreeable. Rarely are we completely indifferent to a stimulus if we give our attention to it. We can think of stimuli as being arranged along a straight line which extends from the most unpleasant at one extreme to the most pleasant at the other. Since the two ends of the scale represent diametrically opposite feelings and attitudes, we are justified in placing them in a straight line. To mildly pleasant stimuli we acquiesce. Strongly pleasant stimuli we move toward or seek after. Mildly unpleasant stimuli cause us to withdraw or to shun them. Strongly unpleasant ones we reject vigorously.

Introspectively, there may or may not be feelings of pleasure or displeasure. One can say of a certain color, "I like it," without at the moment experiencing any noticeable pleasure; or one can say of an odor, "I dislike it," without at the moment experiencing displeasure. Such verbal reactions are called "judgments." While they may reflect most our feeling experience at the moment, they also reflect a long series of previous experiences, with those particular stimuli and with similar ones. We have no yardsticks with which to measure the strength of feelings, as such. But we can use judgment as our basis for measurement, as we shall soon see.

Affective Value. Since stimuli can be more or less pleasant, and also more or less unpleasant, we have a quantitative scale in the line that extends from pleasantness to unpleasantness. The position of any stimulus on that line is called its *affective value.** There are methods by which we can assign numerical values to stimuli to denote their positions on this scale. These methods all depend upon choices or judgments of individuals.

Methods of Measuring Affective Value. The three most common methods of evaluating stimuli are as follows:

(1) *Ratings.* In this method, human judgments are usually given in terms of numbers. A typical scale defines the numbers something like this.

10	Most pleasant imaginable
9	Greatest possible pleasantness
8	Extremely pleasant
7	Moderately pleasant
6	Mildly pleasant
5	Indifferent
4	Mildly unpleasant
3	Moderately unpleasant
2	Extremely unpleasant
1	Greatest possible unpleasantness
0	Most unpleasant imaginable

* Also called *hedonic tone* by Beebe-Center and others.

The affective value to be assigned to a stimulus is the average of the ratings assigned to it by a number of similar, competent judges. Individuals will not all necessarily agree upon the same value nor will the same individual give the same identical rating at different times. But the judgments will usually cluster about a midvalue which can be taken as the typical affective value for that particular group of judges. Results given by one group are very close to those given by a group of similar individuals.

(2) *Pair Comparisons.* If you do not wish to assume that your judges can give judgments of this kind, you may resort to another method. It is easier for the average person to say that one stimulus is preferred to another than it is to give both absolute values on an arbitrary scale. So we may pair each stimulus in our set with every other one, and ask a large number of judges to say which one of each pair they prefer. We can find the percentage of the judges who prefer stimulus A to stimulus B, also stimulus A to C, and B to C, and so on. For a concrete example, suppose A is beefsteak, B is fried chicken, and C is roast lamb. If any two are equally preferred, that is, if they come at the same place on the affective scale, the one will be preferred to the other just 50 per cent of the time. The more lopsided the preference between a certain pair, the farther apart they are on the scale.

Because of certain mathematical relationships, too involved to be described here, we can estimate scale separations between pairs of stimuli. Knowing the separation between every pair of stimuli, we can give them all numerical values on the affective scale. The process cannot be described in full here. An example of some stimuli that were scaled in this manner may be seen in Fig. 8.5.

(3) *Rank Order.* The method of pair comparisons is often a long and tedious process. A much shorter and often just as effective method is to ask each judge to place the stimuli in rank order of his preference, placing the best-liked one at the top and the most-disliked one at the bottom. From the combined rankings of a number of judges we can compute scale values much as we do from judgments by pair comparisons.

Factors Determining Affective Value. The reasons for liking and disliking stimuli are numerous. It is likely that certain colors, tastes, and odors are preferred to others because of inborn nervous dispositions. Pleasantness and unpleasantness have always been useful though not infallible guides as to which stimuli should be sought after and which ones should be rejected. In the long run stimuli that are normally pleasant to us have been beneficial to life, and stimuli normally unpleasant have been dangerous. There are numerous exceptions. Sweet substances promise quick and easy supplies of energy; but alcohol and opium are sweet. Bitter substances are likely to be poisonous; but many of them in the form of medicines are beneficial. The pleasantness-unpleasantness system has worked only in a crude way to select and reject stimuli. More discriminating devices came into existence as the cerebral cortex developed.

Affective Value of Colors. Before we can state which colors are liked best and which ones least, we must remember that there are many aspects to a color and to what determines likes and dislikes for it. It must be recognized that there are fashions in color. One color will grow in popularity for a time, then give way to another. We like houses in some colors but not in the same colors as we like gowns or shoes or hats. The first important question is whether there is any common denominator in our preferences for colors when use is not a consideration.

Most of the experimental studies of this problem, and there have been many, have used rather small numbers of colored paper as stimuli. Interest has usually centered in the more common, well saturated ("gay") colors, such as red, orange, yellow, green, blue, violet and purple, and in black and white. The results have shown rather general agreement that red, green, and blue (mentioned in increasing order of liking) are preferred to the other colors just mentioned. This very general result has held true for many races of people, with surprisingly few exceptions.

But even with colored papers as stimuli, we need to consider several aspects of a color. Colors differ with respect to *hue* (dependent primarily upon the dominant wave length), *tint* (the

degree of lightness), and *chroma* (the saturation or richness or "loudness").* For example, there are light reds (which we call pinks) and dark reds (which we call maroons or reddish browns). There are straw yellows, canary yellows, mustard yellows, and also tans and yellowish browns, all with the same hue—yellow—but differing in tint and in chroma (saturation). The scientific problem is to determine whether there is any systematic relationship between affective value and each of the three variables of color—hue, tint, and chroma.

This calls for an experimental approach. We must hold constant both tint and chroma while studying the effect of hue on affective value. Then, in turn, we should vary either tint or chroma while holding the other two variables constant. Such a study has been made, using over 300 different color samples. The stimuli were 2 in. by 2 in., all displayed against a large neutral gray background. Each color sample was specified as to hue, tint, and chroma according to the Munsell color system (see Ch. IX). Judgments of liking or disliking were made on the numerical rating scale mentioned earlier in this chapter. Two judgments were obtained for each color sample from ten men and ten women and average affective values were found for each stimulus.[1]

Fig. 8.1 shows some of the results, based upon the judgments of the women. For all colors represented in this figure, the chroma level was constant at 6 points on the Munsell scale. None of these colors is very well saturated, for maximum saturation is at 14 points on the chroma scale. Colors with zero chroma have no hue at all; they are on the line running from white to black. Each curve in Fig. 8.1 represents affective values for colors at a constant tint level. A tint level of 9 is almost white and a tint level of 1 is almost black. The levels represented in Fig. 8.1 range from 3 to 8.

Fig. 8.1 is somewhat typical for others at different chroma levels, at least as to the high and low places in each curve. The order of preference for the main hues is blue (first), followed in order by green, purple, red, orange, and yellow. The lowest

* For further explanation of these terms, see Ch. IX.

preference is slightly on the green side of yellow. With the indifference point at 5.0 on the affective scale, it can be seen that some of the yellows (at tint 8) are liked while some of the reds and purples (at tints 3 and 4) are disliked.

In general, the lighter the color the better it is liked. There are some exceptions to this at other chroma levels than this one represented. When chroma is zero, for example, only black is on the pleasant side. Most grays are rated as unpleasant and white and light grays are rated on the average at the indifference level.

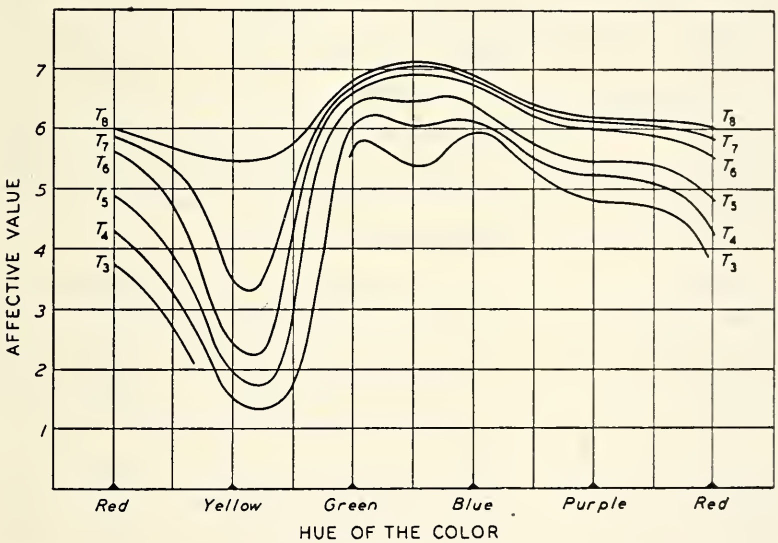

FIGURE. 8.1. The trend of liking and disliking for various hues throughout the color circle when the lightness of color samples varies and the saturation or chroma is kept constant near 6 on the Munsell scales (see Ch. IX).

Not shown in Fig. 8.1 is the fact that on the whole the affective value increases as chroma increases. It is very likely that if the size of the stimuli were increased many of the saturated colors would be less preferred. We quite readily accept a wide expanse of blue sky and of green landscape. We would not like the walls of our room to be a vivid purple or a vivid orange. Size, then, is another determining factor that must be studied systematically as well as hue, tint, and chroma. There are other determiners, also, such as illumination, texture, and background, to say nothing of use.

The preference for the cooler colors, green and blue, is also found among some lower animals, particularly in goldfish and in the albino rat.[2] Very young children, however, prefer red and yellow above blue and green. They prefer lighter colors and saturated ones during the first year. After the second year, yellow sinks to its low position in the adult scale of preference, and blue and green rise above red.[3] These changes to the adult scale are complete at the time of adolescence.

Little is known definitely about the preference for color combinations, although artists often make positive statements about this point. There is agreement that pairs of colors are preferred when the difference in hue is either very small or very large. Complementary pairs, or near-complementary pairs, are liked better than others. Large differences in tint are preferred, but small differences in chroma are liked best, other things being equal.[4] Feelings for color harmony may appear in the four-year-old child, but usually not until the age of eight.[5]

Affective Values of Odors. Fig. 8.2 shows graphically the average ratings of eight judges for 13 common odors.[6] In terms of the primary odors (see Ch. XII), we may say that the four primaries, flowery, fruity, resinous, and spicy, are pleasant odors, and so are odors that resemble these four strongly. The other two primaries, putrid and scorched, and their derivatives, are generally unpleasant. The biological usefulness of this arrangement is obvious. The first four primaries promise beneficial foods; the last two, on the whole, warn of unhealtful objects.

Tests show that odors disgusting to adults do not affect children the same way until the age of 5. By the ages of 7 or 8 the normal rejecting responses appear.[7] Other tests show that odor stimuli so weak that they are not noticed may cause aversions. Students went from house to house with four identical new pairs of ladies' hose, one pair of which had been treated to overcome the mildly rancid odor left in the hose at the factory. Housewives generally judged the treated pair to be of better quality than the others although odor as such was not noticeable.[8]

Affective Values of Tastes. Most animals have a "sweet tooth," even goldfish. Salt is pleasant in moderate quantities when de-

sired. Sour and bitter are almost always unpleasant, although at the right intensities and in the right places they also are desired. It all depends upon the intensity of the stimulus and the mood or desire of the individual. When satiated with sweets, even candy is likely to become repugnant for a time.

Affective Value of Sounds. In considering the relation of affective value to simple sounds, we need to keep in mind the

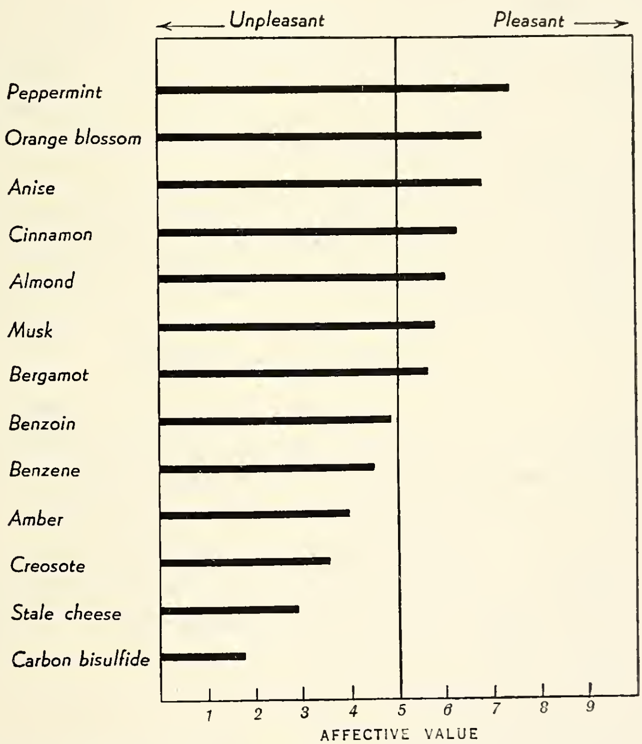

FIGURE 8.2. The affective values of some common odors as rated by eight students.

two most important ways in which sounds differ. They differ in pitch and in loudness. Young has found that in general, high-pitched and loud tones are usually unpleasant while low-pitched and soft tones are usually pleasant.[9]

In general, musical tones are preferred to noises, although children often enjoy noises more. The combinations of two musical

tones at a time in musical intervals give varying effects. The combinations of sounds into patterns of speech and music carry us over into the field of esthetics which is to be discussed in later pages.

Learned Likes and Dislikes. The likes and dislikes discussed up to this point depend very much upon innate factors. A multitude of human likes and dislikes are undoubtedly learned, even for simple stimuli like colors and tastes. A certain young woman dislikes reddish brown decidedly. She has forgotten that as a child she fell from a swing and became panic-stricken at the sight of blood that spurted from a wound on her head. Children have been trained to like colors that were presented simultaneously with toys or cookies.[10] Music played while poor children were eating free meals became highly pleasant, though formerly it was disliked.[11] Make any stimulus seem an integral part of the process of gratifying a motive, and it is likely to become pleasant. Make any stimulus an integral part of the process of thwarting a motive or of raising a tension, and it becomes unpleasant. These are the fundamental laws of learning likes and dislikes.

The Law of Affective Contrast. The affective reaction to a stimulus depends to some extent upon the presence of other stimuli and their affective values. Ask an individual to rate a set of odor stimuli. Then impose upon him a set of very unpleasant odors, and then repeat the first experiment. His ratings of the original set of odors now go higher. The reverse change in ratings occurs after he experiences a set of very pleasant odors. Thus we see that ratings of affective value are not made independently. They are made on the background of many previous ratings. The influence of the other stimuli upon the present one will depend upon how recently they were applied and how similar they are to the present one.

This phenomenon is merely a special case of an even more general psychological law of relativity. Another example is the apparent heaviness of weights. Let an individual judge a series of lifted weights ranging from 200 grams to 400 grams by reporting such categories as "very light," "light," "medium," "heavy," and "very heavy." Let him at a later time rate the same weights

after he has been lifting weights around 100 grams. Again, let him judge the weights after he has been lifting weights around 800 grams. The weight that he is likely to call "medium" in the second series will be actually lighter than in the first. The weight he is likely to call "medium" in the third series will be actually heavier than that in the first series. This seems best explained by means of Helson's concept of the *adaptation level.*[12] When an organism has been subjected to a series of stimuli of similar nature, his nervous mechanisms undergo a systematic change of base or level of equilibrium in the direction of a kind of average of all those stimuli. Later stimuli are evaluated on the background of that base, whatever its level.

So far as affective state is concerned, the happiness of an individual seems very dependent upon his level of feeling adaptation. The soldier who has lost both his legs in battle says he feels very lucky to be alive. The young man who has never served in the armed forces is very irritated and depressed because he cannot buy a new model car on account of war restrictions. Their adaptation levels of feeling are very different.

The Law of Affective Combination. When two stimuli are combined, that is, two colors, odors, or a color combined with a form, the affective value of the combination bears a definite relation to the affective values of the two components. Two pleasant stimuli usually combine to give something more pleasant than either taken alone, and two unpleasant stimuli combine to give something more unpleasant than either one alone. The summation is not complete, for there is some loss in affective value. The combination of a pleasant with an unpleasant stimulus usually yields some cancellation; the result lies somewhere between the two when taken alone. When two or more stimuli give a complex experience in which the identities of the parts are wholly or almost wholly lost, the values of the single stimuli may be very much obscured. A musical chord is an example of this.

Annoyances. Annoyances represent aversions that are more than unpleasant; they have at least a trace of anger. Cason has collected numerous specimens of annoyance as given to him by 659 individuals.[13] A few examples are:

To hear a person chewing gum loudly.
To see a person's nose running.
A person bragging about himself.
An effeminate man.
To be pushed in a crowd.
To see or hear an animal being cruelly treated.
To wait for a person who is late.
To find some dirt in the food I am eating.
The odor of bad breath.
To see excessive cosmetics on a woman.

Summarizing the results, Cason concludes that all annoyances may be classified as follows:

Type of Annoyance	*Per Cent*
Behavior of others	57
Non-human things and activities	16
Clothes and manner of dress	12
Alterable physical characteristics of others	10
Unalterable physical characteristics of others	5

The moral of this list is obvious. The greatest source of annoyance is other people and what they do. A small percentage of this is beyond control, but to avoid annoying others we can change the rest.

Esthetic Preferences

With more complex stimuli, when sensory organization is demanded, the appreciation of the object is something more than mere pleasantness. It is esthetic experience. Beauty is a property of some perceived objects and not of others. It is something like a meaning, though not a meaning that leads to use or to knowledge about the object. The best example is seen in music.

Beauty in Music. Music is a complex pattern of sounds that conveys no knowledge or meaning in the ordinary sense of the word. Even so-called descriptive music brings to the listener little or no information. Music intended to express farewell or early morning will leave no such ideas unless the listeners are given some broad hints to that effect. Music seems to be enjoyed merely because it brings to the listener an organized pattern, but a pat-

tern having certain properties. Music that we cannot organize, we do not like.

Of all the aspects of music—melody, rhythm, harmony, and counterpoint—melody is the chief determiner of appreciation; then come rhythm and harmony. Repeated hearing of music of the masters that at first is too complex for us eventually leads to better organization, and hence enjoyment.

Beauty in Paintings. Very much the same holds for compositions of line and color. Arrangements that give balanced, symmetrical, and familiar forms within our powers of organization are more appreciated. According to Ogden preferred forms in art are patterns that conform to the principles of our own nature.[14] For example we are in general bilaterally symmetrical, so we prefer symmetry. Our own movements are inclined to be rhythmical and we are inclined to organize sensory material into equal, comprehensible units, so we appreciate rhythm. We experience difficulty in resisting the forces of gravity, so we glory in the gracefully poised figure.

The fact that children prefer to look at pictures drawn by other children, rather than at the work of adult artists, indicates that ease of organization has much to do with the esthetic effect. The fact that adults prefer adult productions, however, shows that compositions too easily organized are also lacking in esthetic appeal. The truth probably is that the most appreciated objects of art are those neither too easy nor too difficult to unify. They must contain possibilities of our creating from them mental structures that are still sufficiently new. Novelty is undoubtedly a factor, and so is mastery, if one wishes to bring in the fundamental motives.

Empathy. Much of our appreciation of the beautiful or the ugly is said to depend upon the process of *empathy*. This means the identification of ourselves with objects. We "feel ourselves into them" as if we temporarily put ourselves in their places. For example, one could scarcely gaze at the leaning tower of Pisa without feeling some degree of discomfort. If we *were* the leaning tower, we should be filled with disagreeable muscular strains. While looking at the tower we may actually have minute muscular

contractions of the kind that we would have if we were in the tower's place. For the same reason, when we see a frail-looking column supporting apparently too much weight we also feel uncomfortable, and when we see a too-massive column supporting apparently a trivial amount of weight we feel the wasted effort.

Empathy can also afford the explanation of agreeable esthetic experiences. Balanced and well-proportioned objects "look" comfortable and poised. Towering mountains and skyscrapers, awe-inspiring storms and massive machinery, all give the normal esthetic thrill, probably because as we feel ourselves into them we

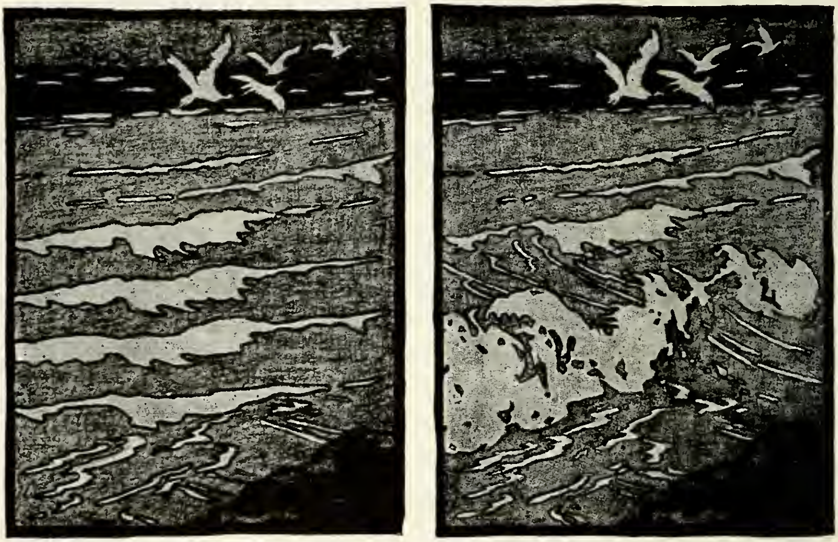

FIGURE 8.3. Which of the two pictures is esthetically better? Ask this question of a number of your friends. (From the Meier-Seashore "Art Judgment Test," courtesy of N. C. Meier.)

share their superior power. Grandeur appeals to our motive of ascendance when we identify ourselves with the large and the powerful, and to our motive of submission when we respect greater power in other persons and things, as we have learned to do. Thus, while empathy seems undoubtedly to be a factor in many esthetic responses, it is probably not a factor in all cases, for in submitting to another power we are not identifying ourselves with it.

Tests of Artistic Appreciation. There are many factors that tend to make us like or dislike a work of art. Some individuals are more sensitive to these factors than others. There are now psychological tests intended to measure the sensitivity of people to esthetic objects. Fig. 8.3 illustrates material from one of them, the Meier-Seashore Art Judgment Test.

INTERESTS

When an organism discovers that certain objects and responses lead to the satisfaction of motives, it shows interests in those objects or responses. This is shown by its going toward the objects, or looking at them, and by its indulging in those responses in preference to other activities. Interests are inclinations to attend to or to seek certain stimuli or to indulge in certain activities. In human organisms, interests are very numerous and sometimes seemingly very complex.

Measuring Vocational Interests. As an example, let us consider vocational interests. It is obviously true that one person finds some occupations much to his liking, whereas he finds others without appeal or even repelling in what they have to offer him. Whether or not an individual likes his work is a very important consideration. Much thought and work have been given in recent years to the task of discovering vocational interests in young people.

Let us take as an example the best-known Vocational Interest Blank, devised by Strong. It contains in verbal form some four-hundred items to most of which the person is to respond by saying that he likes, dislikes, or is indifferent to the thing suggested. A section on amusements, for example, is arranged as follows, the individual encircling L, I, or D according as he likes, is indifferent to, or dislikes each particular item:

Taking long walks	L	I	D
Camping	L	I	D
Driving an automobile	L	I	D
Poker	L	I	D
Art galleries	L	I	D
Detective stories	L	I	D
"New Republic" magazine	L	I	D
"Ladies Home Journal"	L	I	D

A list of general activities is to be judged in the same manner:

Giving "first aid" assistance	L	I	D
Attending church	L	I	D
Doing research work	L	I	D
Looking at shop windows	L	I	D
Saving money	L	I	D

Another section is on peculiarities of people:

Energetic people	L	I	D
Thrifty people	L	I	D
Very old people	L	I	D
Methodical people	L	I	D
Foreigners	L	I	D

School subjects are also to be rated:

Algebra	L	I	D
Dramatics	L	I	D
Languages	L	I	D
Music	L	I	D
Philosophy	L	I	D

Still other items include the names of people admired most, special activities liked or disliked, and personal characteristics.

It has been found, by studying the reactions to all the items, given by hundreds of men and women in different occupations, just which likes and dislikes are characteristic of the people who are contentedly engaged in each occupation. By statistical methods, it is possible to score an individual's reactions for his probable degree of interest in some forty occupations for men, and some twenty occupations for women. The results are not always infallible, and the choice of occupation should never be made on the basis of a score taken by itself. Many other factors cause success or failure in an occupation, and various circumstances other than interests must be considered in the choice of a vocation. Follow-up studies have shown, however, that men rating high for interest in selling insurance, for example, do much better in their work than those rating lower.[15]

The number of occupations is so very large that the idea of testing and scoring a person for all of them is a physical impossibility. For this, and other, reasons, other inventories have been developed with some effort to score the psychologically basic interests. Basic interests are probably very much in line with the

distinguishable motives. They are important to various degrees and in various combinations in connection with each occupation. If we knew, let us say, 20 scores for a person, each in measurement of a single basic motive, we should then be able to predict

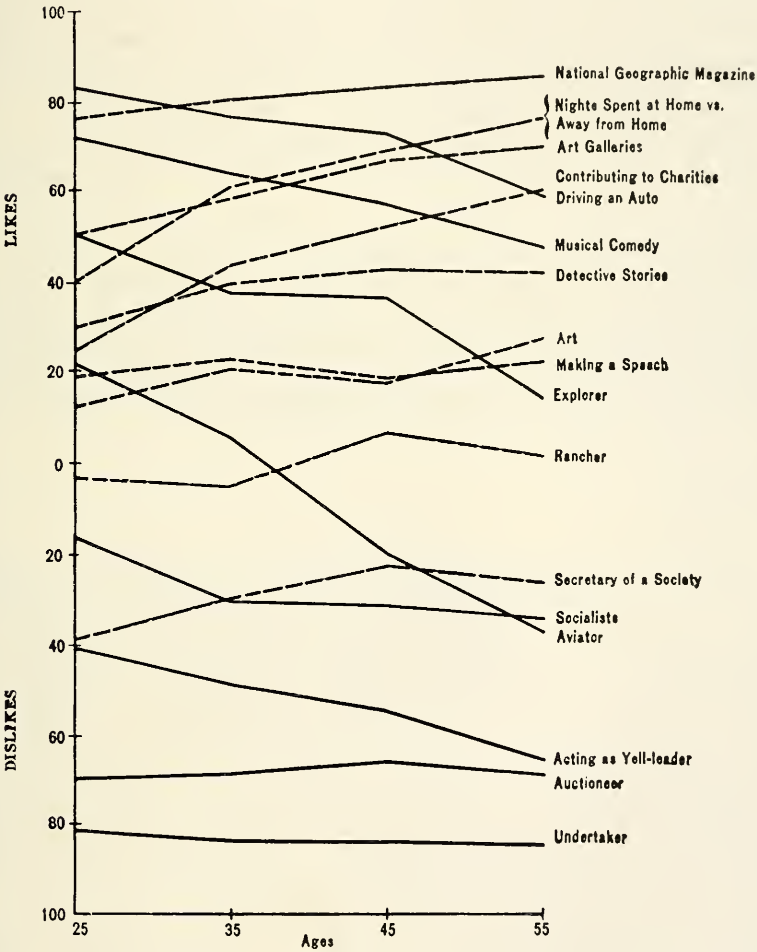

FIGURE 8.4. Changes of interests of men with age, between the ages of 25 and 55. (From P. T. Young, *Motivation of Behavior,* John Wiley & Sons,, Inc.).

from combinations of these scores the probable interest in each occupation.

Changes of Interests with Age. The results from hundreds of men between the ages of 20 and 60 show some very interesting

facts about their likes and dislikes. Within this range interests differ most with age between the years 20 and 35. They differ much less between 35 and 55, and almost none between 55 and 65. In general, the interests characteristic of men in the various higher vocations are not mature until the ages of 30 to 35. The trends in a few specific interests are shown graphically in Fig. 8.4. Those represented by the solid lines tend to decline with older men, and those represented by dotted lines tend to gain in preference.

Items suggesting physical skill and daring change most of all with age. Items showing dislike for interference with established routine come next. Indulgence in writing or speaking loses its appeal for older men, but reading gains in interest. Amusements are popular at all ages but tend to decline in preference with age, except the more cultural ones, for which there is some gain. In general, the things men like at 25 are liked better with increasing age, and the things they dislike are disliked more and more. There are, of course, some exceptions to this rule.

Attitudes

Our attitudes toward other things and other people are very complex dispositions to accept or to reject. We are favorable or unfavorable toward a person, an institution, a proposal, or a social issue. The positive or negative tendency is apparent in every attitude. We are for or against something. In a general sense, mere preference based upon pleasantness or unpleasantness, an esthetic judgment or the expression of an interest, all may be called attitudes. We usually restrict the term, however, to social matters as in the following examples. The attitude may be conscious or unconscious, verbalized or unverbalized, and active or inactive at the moment. For example, you may be favorably disposed toward college football as a sport. This attitude is a more or less stable *set* of yours that predisposes you to buy tickets to games, to talk football, and to do other things, but only when certain occasions arise.

Scales of Attitudes. Suppose the attitude in question is that toward capital punishment. One person you meet is strongly

against it and another is strongly for it. Still another is indifferent, or if he has any feeling at all on the matter, he is rather lukewarm. This implies a scale extending from an extremely favorable attitude to an extremely unfavorable attitude, with an indifference point in the center. In many respects it is similar to the general affective scale. Each person who has acquired any sentiments on the question of capital punishment at all is probably on the favorable or the unfavorable side of the indifference point. His characteristic position on the scale can be determined in the following manner.

The Construction of an Attitude Scale. First, it is necessary to construct an attitude scale. An attitude scale is usually composed of a number of statements of opinion concerning the issue or institution. Attitudes are revealed to a large extent by opinions that people express or accept as their own sentiment. If a person says concerning capital punishment in all seriousness, "Every criminal should be executed," you conclude that he is decidedly in favor of it. If another person says, "The execution of criminals is a disgrace to civilized society," you conclude that he is very much against it. Neither statement alone would enable us to place a person very accurately on the scale.

We therefore collect a large number of potentially usable statements which seem to be distributed all along the scale of favorable and unfavorable opinion. In one method, we ask a number of competent judges to evaluate each statement on a scale of eleven steps. The average step value for each statement is the indication of the scale position of that statement. We then select some 20 to 25 statements of opinion that are about equally spaced along the scale and that seem pertinent and clear. These statements then make up our yardstick for measuring the scale positions of individuals and groups.

The Measurement of Attitudes. As an example of opinions that have been evaluated for strength of opinion about capital punishment, the following statements and their scale values may suffice:

Statement *	Scale Value
The execution of criminals is a disgrace to civilized society	0.9
Society can deal with crime effectively without resorting to capital punishment	2.9
Capital punishment is wrong, but it is necessary in our imperfect civilization	6.2
Capital punishment is undesirable but it is essential for the safety of the group	7.7
Capital punishment should apply to other than murder cases	9.8
Every criminal should be executed	11.0

* Quoted by permission of L. L. Thurstone.

An individual's position on the scale is determined by asking him to state which opinions he himself believes. An average of the scale values of the opinions to which he subscribes places him at some position on the scale. Similar attitude scales have been prepared by Thurstone and his associates for such social factors as communism, prohibition, patriotism, war, the law, belief in evolution, censorship, birth control, the Bible, God, the church, and Sunday observance. These serve as measuring instruments for the study of the causal factors of attitudes and of changes in attitudes.

Changes in Attitudes. Certain changes in attitudes have been very neatly detected by means of attitude scales. For example, the children in two different schools were given attitude scales concerning their approval or disapproval of the Chinese. One school was then shown a motion picture favorable to the Chinese, and the other school was shown a film that was unfavorable. In the first, there was a decided shift of opinion of the Chinese in the more favorable direction. In the second, there was a smaller shift in the unfavorable direction.[16]

By using the method of pair comparisons, a study was made concerning the effect of a motion picture entitled "Street of Chance" upon children's attitudes toward gamblers, who were shown in an unfavorable light in the film. Thirteen names of crimes were presented, each paired with every other one, both before and after showing the picture. The children were asked to say which one of a pair was the more serious or wrong. As Fig. 8.5 shows, all the crimes except gambling kept almost exactly the same scale positions. Gambling rose definitely toward the more serious end of the scale.[17] Whether or not these measured changes in attitude are permanent does not concern us here.

No doubt most attitudes are continually shifting under the pressure of changing conditions. The point is that we have the necessary psychological instruments for measuring the attitudes of individuals and of groups. Thus we can make a scientific or a practical study of their changes and of their causal factors.

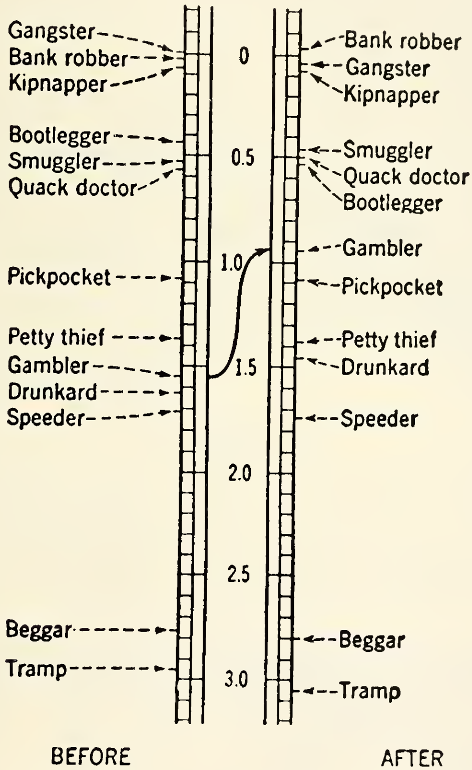

FIGURE 8.5. The shift in attitude toward gambling as a result of seeing the motion picture "Street of Chance," in which gambling was shown in an unfavorable light. Note that all other crimes retained approximately their former scale positions. (Courtesy of L. L. Thurstone.)

Attitudes of Groups. Modern public-opinion polling is designed to assess the general level of attitude of groups on many issues of current importance. The questions asked may concern political, military, religious, commercial, or economic questions of the day. The result is usually given in terms of percentages who favor or do not favor each proposition. The sampling of

opinion on the same issue from time to time reveals trends, whether it be for the popularity of the president, or a particular political party, or whether to draft 18-year-olds. Fig. 8.6 shows one example of the trends of opinion.

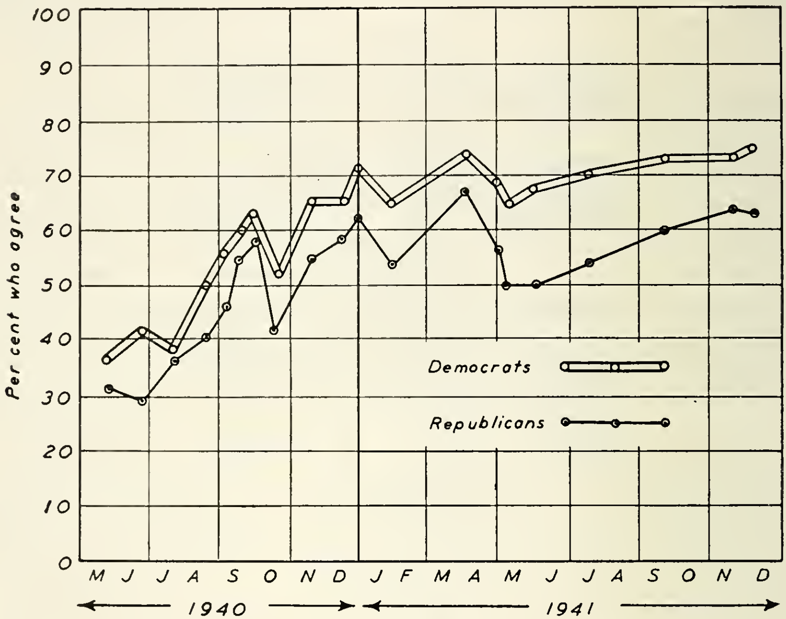

FIGURE 8.6. In a public-opinion poll during 1940 and 1941 the question was asked "Which of these two things do you think is more important for the United States to do—to help Britain, even at the risk of getting into war, or to keep out of the war ourselves?" The percentage of those who chose the first alternative is shown for Democrats and Republicans sampled almost monthly. (After H. Cantril, *Gauging Public Opinion*, Princeton University Press.)

Summary

Likes and dislikes for various kinds of stimuli are now measurable on a scale of affective value that extends from extreme pleasantness at one end to extreme unpleasantness at the other, with an indifference point near the center. There are apparently deep-seated and rather universal likes and dislikes for colors, tastes, and odors, and a factor in this is the intensity of the stimulus. Likes and dislikes are also learned. Annoyances are dislikes tinged with anger. The majority of human annoyances arise with other

people and what they do, and most such occasions for annoyances are avoidable.

Esthetic preference involves more than liking or disliking. It requires complex stimuli to arouse an esthetic experience, which is bound up with the process of sensory organization.

Interests are positive expressions of motives. We are interested in those things that promise gratification of motives. Even complex patterns of interests, such as those entering into the liking or disliking for a vocation, are now measurable by means of psychological inventories. Interests change with age, but remain fairly stable after the age range of 25 to 35.

Attitudes are dispositions to favor or to reject an object. As with likes and dislikes, an attitude toward any object, including social institutions, can vary all the way from complete acceptance to complete rejection. An individual's position on such a scale is now measurable. Changes in attitude due to various causes can now be studied scientifically.

Questions

1. Relate likes, interests, and attitudes, in a general way, to motives. Discuss briefly.
2. How can we account for the great variability in the liking for a certain object from person to person and in the same person from time to time?
3. Of the three methods, rating-scale, ranking, and pair comparisons, which seem to you the most natural, and which the most reliable? Why?
4. Collect a large number of "annoyances" from your friends, perhaps 50 to 100. Classify them according to the categories given by Cason. Do your own percentages in the different categories agree with those of Cason?
5. Ask a number of your friends which occupations they have chosen, and to tell, if they can, what factors determined their choices. What proportion of those reasons come under the heading of interests?
6. Try to explain the changes of interest that appear with age, as shown in Fig. 8.4. Which ones, if any, seem unreasonable? Why?
7. Collect from a few friends a number of statements of opinion regarding their attitudes toward censoring of the movies. Selecting the most clear-cut statements, assign them scale values from 1 to 11, 1 being the most unfavorable toward censorship of the movies, and

11 the most favorable, with 6 at the indifference point. Ask a friend to repeat the scaling, and compare notes. Give your conclusions.

8. How can we account for the fact that the overt behavior of a person sometimes differs from what we would expect from his expressed attitudes?

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CHAPTER IX

Seeing: Colors

The Importance of Our Senses

Since all mental activity, with little possible exception, begins with the stimulation of sense organs, the importance of the senses for psychology cannot be denied. All that we do and most of what we become depends upon them. All of what we call human knowledge is built directly or indirectly upon what we receive through the senses. While sensations in themselves are not knowledge, they furnish the raw materials out of which knowledge comes.

In order to appreciate any sense to the fullest extent one has to ask himself how it would be to lack that sense entirely. The blind and the deaf, in particular, and a few others who may lack the sense of smell or of taste or of pain, can testify as to what the deprivation of any sense means. The kind of mental activity we exhibit is determined to no small extent by the range of sensitivity we possess. Even our conception of the world and of ourselves is a consequence of the kinds of senses we have. Imagine the descriptions of the world that would have arisen had human beings been endowed with less than the normal number of senses or had they been endowed with additional senses that responded to radio waves, X-rays, and cosmic rays.

Some thirty years ago the student of beginning psychology found that the topics of sensation and the senses occupied a very

large part of the subject. Today only a small proportion of introductory textbooks is devoted to the subject. This does not mean that psychologists are no longer interested in the senses but that other interests and developments have made rapid strides. As a matter of fact, there is an enormous literature on the psychology of the senses and it is still growing.

When a *Psychology for the Fighting Man* was written during World War II it was found that the senses deserved considerable

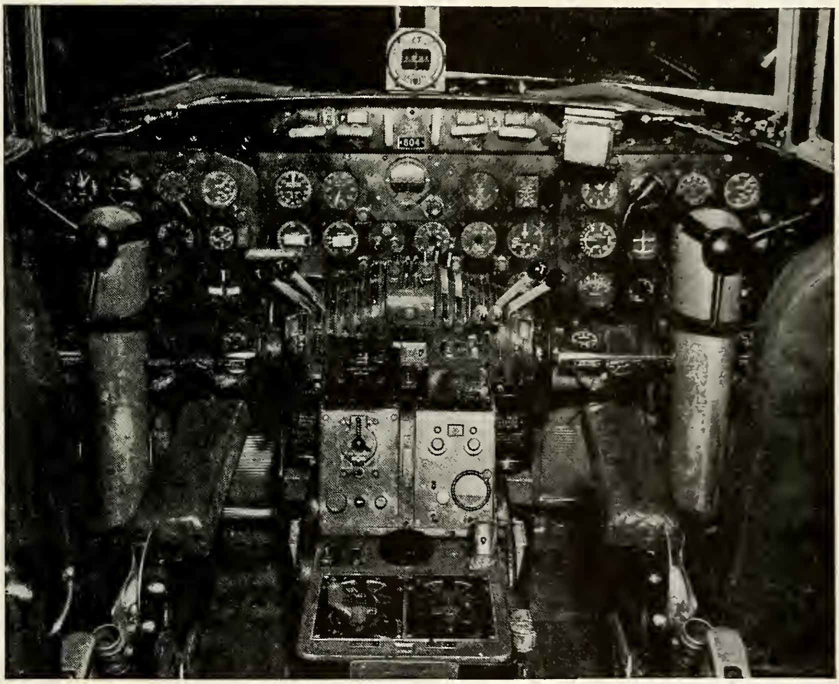


FIGURE 9.1. Part of the instruments in the cockpit of a modern transport airplane illustrating the enormously complicated sensory task presented to the pilot. (Courtesy of Western Air Lines.)

space because of the great usefulness of the subject in military operations. During the war, and since, considerable research work has been directed to solving problems of the senses. One important reason is that war, as well as industrial production, involves the operation of many types of gadgets and machines. Increased speed and complexity of mechanical equipment have taxed severely

man's sensory and motor capacities. It is important to know the minimum limits of capacity for seeing and hearing that can be tolerated for the safe and efficient operation of each important device. It is important to design equipment so as to take advantage of normal sensory powers and to assure that senses shall not be unduly fatigued. It is also important to avoid errors of observation in the reading of dials, scales, and other indicators. It is now believed, for example, that a certain unfortunate peculiarity of the altimeter (altitude indicator) in airplanes frequently led to the pilot's impression that the airplane was 1000 feet higher than it actually was. Some serious crashes of military and civilian airplanes have probably been due to that one error alone.

The Importance of Vision. The average person, faced with the alternative of losing one of his senses, would probably cling to his sense of sight to the last. Certain it is that vision gives us much more extensive and accurate knowledge of the outside world than does any other one sense. Stimuli must be in contact with the skin, or nearly so, in order to arouse the sense of touch. The skin receptors give us little exact information about the form, size, and location of objects and of their properties. The distances within which we can receive sound stimuli are rather limited; ordinarily to a mile or two at the most. The eye responds to the most distant stars if they are large enough. One advantage of hearing over vision is that sound waves can travel through walls and around corners. But our power to locate objects by sound alone is very limited and undependable. The sense of smell merely tells us of the presence or absence of certain objects which can be located and fully recognized only by means of vision.

What We See. Ask the average man what he sees and his first thought is of objects, which is quite correct from the common-sense point of view. He does not often feel the need for further analysis of seeing, although he does recognize that an object has several aspects. Among these aspects are color, shape, size, pattern, and position. If it is a moving object, movement also may be seen. It is quite probable that we possess rather distinct mechanisms for seeing color, pattern (including shape and size), space, and

movement. This chapter and the next will discuss these aspects of seeing, in turn.

Seeing Colors

The Importance of Color. The value of color to human life, whether primitive or highly civilized, cannot be denied. Think what the world would be like if all color were removed. If we include black and white and gray in this statement, of course, there would be no vision at all. But even eliminating everything from the visual world except the colorless lights, the world would look to us as it does in an ordinary photograph, rather drab and uninteresting. The emotional and artistic values of colors are generally recognized. Their everyday practical value is also common knowledge. We identify objects by their color. Substances and their properties are discriminated by their colors. The almost unlimited variety of colors in all their shades and nuances enables us to carry our discriminations to a very fine degree.

Other Sciences Interested in Color. Psychology is not the only science that is interested in the problems of color, although colors as such belong strictly to the field of psychology. Physics and physiology also treat problems of color. But physics is interested primarily in the stimuli that arouse the colors we see, and physiology is interested primarily in what the eye, the nerves, and the brain do when we see colors. Physics tells us about the light waves and how they are transmitted to our receptor cells. Its problem stops there. Physiology tells us how the eye receives light energy, transforms it into nerve impulses that travel to the brain, and what the brain cells do as a result. Psychology is interested primarily in how colors look to us, as conscious phenomena, how we use them in the processes of adjustment, and what effect they have upon us. We do not see light waves; we do not see nerve impulses or brain waves; we see colors. These phenomena, light waves, nerve impulses, and colors, represent three totally different manifestations of natural energy that should not be confused.

The World of Colors. We shall begin the study of colors purely from the psychologist's point of view, then we shall try

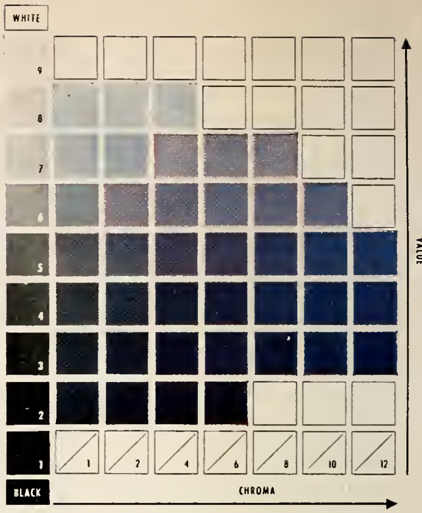
to correlate colors with the kinds of stimuli that produce them, and finally we shall see how colors depend upon the eye and other factors.

The Classification of Colors. It has been estimated that the normal human eye can distinguish about 340,000 different colors.[1] Other estimates may place this figure higher. Can we find any kind of order or system in this extremely variegated world of color? The chemist has his periodic table of elements and the biologist has his system of classifying plants and animals. Such a system serves as a shorthand memory device, for once one knows the principles of the system a vast collection of facts is taken care of. A system also yields new general laws. No one has yet given names to the 340,000 colors. Our language contains only about 300 words that may be used to describe colors, and the average man's vocabulary probably employs only a score of those words in everyday use. The artist, the painter, the manufacturer of papers, inks, and fabrics, however, feel the great need for a means of communicating with others about colors, as does the pharmacist, the decorator, and the designer of clothes. Psychology supplies a workable system.

The Achromatic Series. The easiest distinction to make among colors is that between the *chromatic* and the *achromatic* ones. Achromatic means literally "without color."

The achromatic colors include the blacks, whites and grays. The chromatic colors include all the rest: the reds, yellows, greens, blues, browns, pinks, etc. The achromatic series extends in a straight line from white at the one extreme to black at the other, with a neutral gray in the middle. There is a continuous gradation between black and white with no gaps. Fig. 9.2, which includes the archromatic series, shows nine definite steps or positions along this series. Actually, the normal individual can distinguish many more than nine steps. A very good observer can detect as many as 570.

The Attribute of Brightness. The only general principle noticed in the achromatic series is the variation in lightness or darkness. A single term to describe this property of colors is brightness; an alternative is tint. The nearer to white the color is, the greater



THE MUNSELL SYSTEM
(Left) Hue circle showing the Principal Hues. Each is number 5 of a family of 10 adjoining hues. (Right) Chart showing all variations in value and chroma for 5PB. The gray scale shows the steps between theoretical black and theoretical white. (Below) Color tree showing the three-dimensional relationship of hue, value, and chroma. (Illustrations by Allcolor Company, Inc.)

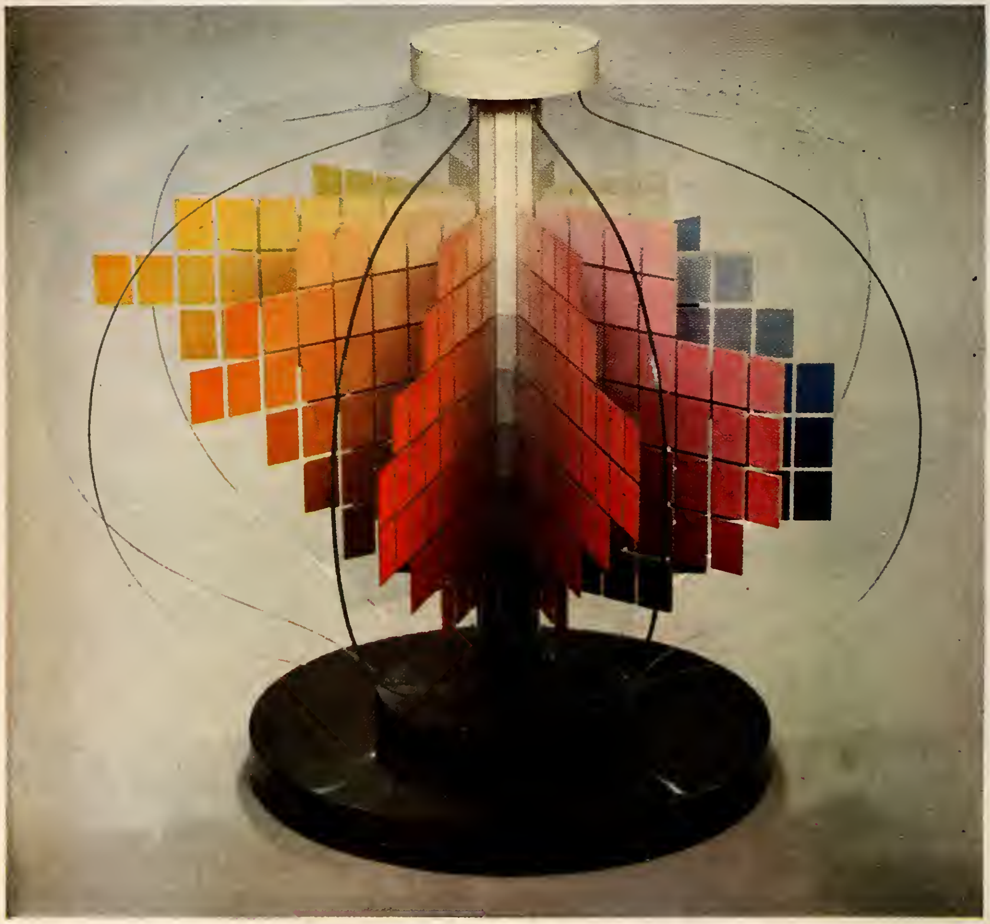


FIGURE 9.2. Illustration of the Munsell color system.

the tint or brightness; the nearer to black, the lower the tint or brightness.

Chromatic colors also vary in brightness. We speak of light blue and dark blue; of pink (a red tending toward white), and of maroon (a red tending toward black). As a matter of fact, every color that exists can be matched for lightness or darkness with some step on the achromatic series; it is high or low on the scale that extends from white to black. Every color, therefore, chromatic or achromatic, has this property of tint or brightness. That is one of the ways in which all colors are identified; that is, by specifying its tint.

The Attribute of Hue. Only the chromatic colors possess this property. A chromatic color is usually named by giving its hue. It is purple, orange, green, violet, red, blue or yellow. The system of hues is shown in the *color circle* in Fig. 9.2. The order of listing them is determined by the degree of resemblance of the hues to one another. The number of distinguishable steps among the most saturated colors in the color circle is probably above a hundred for the normal eye and may reach as many as 160 for a good observer.

The Attribute of Chroma. Chromatic colors differ in still a third respect, namely, in *chroma* or *saturation*. A saturated color is a rich, strong, or "pure" color. Pale or "washed-out" colors and dull or "muddy" ones are unsaturated or somewhat lacking in chroma. Another way of defining chroma is to say that it means freedom from mixture with gray.

Fig. 9.2 illustrates the factor of chroma for a single hue, purple-blue. (A purple-blue resembles both purple and blue but is more blue than purple.) At the extreme left of the triangle is a vertical column showing the achromatic series. In this column we find *zero* chroma. As we go toward the right we find more and more chroma. In every *column* of the diagram we find uniform saturation. In every *row* of the diagram we find uniform tint. The hue is constant, that is, the purple-blue, throughout all rows and columns of the triangle.

A System of Color Naming. Imagine a similar triangle for every hue. Fig. 9.2 also shows a few such triangles for selected

hues. Putting all colors together in this manner we have a color solid. Any color whatsoever can be described in terms of this system. Books of color charts, each like the triangle in Fig. 9.2, have been published for the purpose of providing specifications for colors. Any example of colored material, paper or cloth, that one wishes to identify can be specified by stating its hue, its tint, and its chroma according to the system. The *Munsell Book of Color* is one of the best-known examples of such a system.

The Stimuli for Colors. We have just seen that from the standpoint of psychology the colors fall into a very neat and orderly system. Three properties or attributes describe the system. Do colors and their attributes correspond with anything in the light stimuli that arouse them? In a general way they do. Light stimuli differ from one another in three ways: (1) in wave length, (2) in

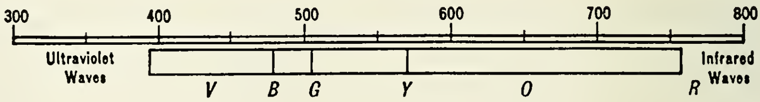


FIGURE 9.3. The dependence of hue upon wave length. The scale at the top represents all wave lengths from 300 to 800 millimicrons (millionths of a millimeter). The visible spectrum from violet to red is shown below it, with the primary hues of blue, green, yellow, and red located at their corresponding wave lengths. Primary red is shown beyond the end of the visible spectrum because the longest visible wave length gives a yellowish red. Primary red requires a little mixing-in of the shortest waves with the longest.

the amount of energy, and (3) in the amount of mixture of different wave lengths. Each of these factors will be discussed in turn.

The Effects of Wave Length. The eye and brain respond to a limited band of waves varying in length from about 390 mμ (mμ = millionths of a millimeter) to 760 mμ, the shorter waves giving rise to violet and blue and the longer ones to yellow and red. It is now recognized that the eyes of individuals below 35 years of age may respond to ultraviolet waves down to 310 mμ. Objects in this light appear violet with a lavender halo around them. There are no single wave lengths corresponding to the purples, and even to the primary red because the longest visible wave gives a red tinged with yellow. Purples and primary red come

from mixtures of very long and very short visible waves. In nature we rarely if ever find pure, unmixed waves of one length. All objects and colored surfaces give off many waves of different lengths. The predominant length of wave determines the apparent hue of the object.

While hue is the most obvious attribute of color that is associated with wave length, both tint and chroma also depend upon this factor. In ordinary daylight illumination the eye responds most fully to waves in the region of yellow and less and less as one goes to the longest and shortest wave lengths. This agrees with the fact that the most saturated reds, blues, and violets are darker. Chroma also depends upon wave length to some extent when energy is held constant. The ends of the band of visible waves give more saturated colors, as a rule, than does the middle.

The Effects of Energy. The most obvious effect of a change in energy of the light stimulus is a change in brightness. The two are positively related. There is also an effect upon saturation as energy is changed. At maximum energy, colors tend toward white, and at minimum energy toward black. Maximum saturations of the various hues are attained at medium energy values of the stimulus.

While in general the lower the energy of light the darker the color, yet the sensation of black is not simply caused by absence of light. We can see the darkest grays and black only in contrast to something lighter, either surrounding the stimulus or immediately preceding it. Black is not a zero sensation; it is as positive a sensation as any other.

The Effects of Mixture. There are several ways in which light waves may be mixed artificially for the eye. The favorite simple way in the psychological laboratory is to prepare a *color wheel* (see Fig. 9.4) or a cardboard disk composed of a sector of one color and the remaining portion of the circle of another color. When this is rotated rapidly, the somewhat sluggish eye gives the impression that the two colors are thoroughly overlapping or mixed. That is, as one sector passes its light over a set of receptor cells in the eye it leaves a continued aftereffect known as the *positive afterimage.* The other sector brings its light to act upon the same

cells while the positive aftereffect of the other is still there. The receptors begin to act very promptly but are slower to end their response. In this way we are able to mix stimuli by means of rotating disks.

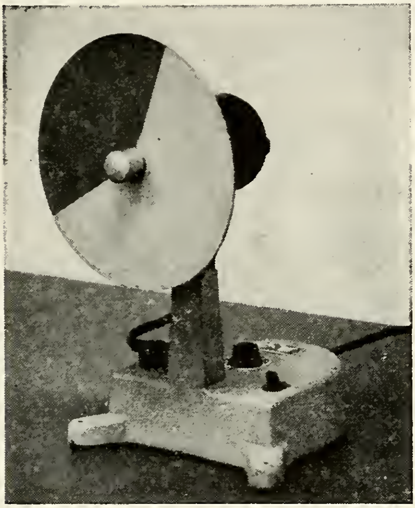


FIGURE 9.4. A disk for color mixing. When rotated at the rate of 20 revolutions or more per second, flicker gives way to a smooth mixture of the two colors.

What happens in terms of hue, tint, and chroma when color pairs are thus mixed? Three laws of color mixture may be stated in answer to this question. (1) The brightness of a mixture is an average of that of the two components. (2) The hue of the mixture will be intermediate to the two hues on the color circle (see Fig. 9.2). (3) The saturation of the mixture is generally reduced. The further apart the two hues are in the color circle, the greater the loss in saturation. When the two hues are directly opposite on the color circle and the proportions of the two components are properly chosen, the loss in saturation is complete and some shade of gray is the result. Such hues are called complementary. Every hue in the color circle has its complement; yellow and blue, red and blue-green, green and purple, are three common pairs of complementary hues.

Nature of the Illumination. We are inclined to think of an object as having a fixed color that is a permanent property of it. Usually we get the idea of its supposedly permanent color from what we see of it in good daylight. Actually, an object gives us quite a variety of changes of color at different times. The only permanent property of the object is its ability to absorb some selected wave lengths and to reflect others. It is the reflected ones that stimulate our eyes.

So long as normal sunlight is the source of illumination, the object stimulates our eyes the same and should look the same when our eyes are in normal condition. But suppose the illumination is artificial, which is likely to mean that it does not emit all the visible wave lengths. To take an extreme case, if the illuminant emits only those wave lengths that the object absorbs, the object should appear black. Most cases in nature are less extreme than this, of course. But the wave lengths coming to our eyes from an object are a resultant pattern of wave lengths which depends upon both the selection in the light source and the selection in the reflec-

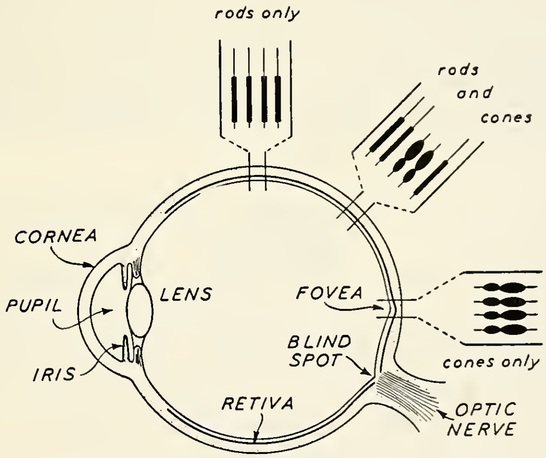


FIGURE 9.5. Diagram of the human eye, showing the location of the fovea, and blind spot. Enlarged sections show a few rods and cones.

tive properties of the object. Thus, the colors of clothing, food, interior decorations, and so on, are very different under artificial lighting than in daylight. Meats in a butcher shop are made to look redder and fresher by using a special illuminant on them. Cosmetics may turn to ghastly colors if the lighting is not appropriate.

There are limits to the effects of the composition of the illuminant, however, as we shall see later (see p. 237).

The Mechanism for Seeing. The eye is an almost complete analogy for the ordinary camera. Both have a sensitive film at the

back and an optical system for focusing an image upon it. The optical system includes the transparent *cornea* at the front (see Fig. 9.5), the *lens,* and the fluids that fill the eyeball. All these parts contribute to the bending of light rays so as to produce a miniature image of the external scene upon the retina. The lens is the only part that is optically changeable. Its curvature is controlled by the *ciliary* muscle attached around its edges. Near objects require a rounder curvature (ciliary muscle contracted) and far objects a flatter curvature in order to give a sharp image on the retina.

An element at the front of the eye is the *iris,* that colored part of your eye that regulates the size of the *pupil.* This corresponds to the diaphragm in the camera and has the same purpose—to control the amount of light that may enter the eye. In the dimmest illumination the pupil may be about 15 times as large, in area, as in the brightest illumination.

The retina. The sensitive film at the back is extremely thin and transparent and yet it contains some very elaborate structures. There are several layers of nerve cells and their supporting materials. The receptor cells are of two kinds, *rods* and *cones,* distinguished by their shapes (see Fig. 9.5).

Two spots on the retina are of special interest. One is the *blind spot,* at which place nerve fibers leave the eye to enter the optic nerve. Though very small on the retina, the blind spot "covers" a sizeable portion of the visual field. A man's head can be made to vanish at a distance of 15 to 20 feet, if its image falls upon the blind spot of one eye and the other eye is closed. Fortunately, in normal vision a sensitive part of the one retina covers any object that falls within the blind spot of the other retina. Should anything obstruct the vision of the one eye, however, even large objects falling within the blind spot of the other will be entirely overlooked. A whole motor car may vanish for this reason if some 200 feet, or less than a city block, away. It is believed that some traffic accidents are caused in this way. The unnoticed car seems to jump out from nowhere. It has possibly jumped out of the blind spot. The approximate position of the blind spot of your visual field may be seen by using Fig. 9.6.

The other important spot in the retina is the fovea. This is a small depression straight back from the pupil. It contains no rods, only cones that are more slender than elsewhere and packed very closely together. The result is that we have the keenest vision in the fovea where the most delicate distinctions can be seen. We do most of our seeing with this small part, turning our eyes toward any object of interest so as to bring it into the foveal region. This fact one can verify in reading a page of print. How much of the print is legible without moving your eyes? Only a word or two.

Daylight and Twilight Vision. Because of the two kinds of receptors we really have two eyes in one; one for normal and strong daylight illumination and the other for twilight and night seeing. The cones are not sensitive to very weak lights, and strong lights are too much for the rods. When lights are dimmed the

FIGURE 9.6. How to locate your blind spot. Closing the left eye, fixate the letter "R" with your right eye and move the book closer until the face disappears. Closing the right eye, do the same fixating the letter "L" with the left eye.

rods grow more sensitive because of the increase of a chemical substance called visual purple. Very essential for the formation of visual purple is vitamin A. One of the first symptoms of a deficiency of vitamin A is night-blindness which is more common than might be supposed, and which may be responsible for many an accident on the highways at night.[2]

Light Adaptation and Dark Adaptation. While the iris, in its regulation of the pupil, adjusts the eye to large differences of lighting, the adjustment of the retina itself is far more important. With the aid of both factors the range of light energy to which the eye can respond is from one to one billion. That is, the strongest light that the eye can receive is a billion times as strong as the weakest light that is visible. The iris gives rather quick adjustments to changing illumination, whereas the retina gives a very slow adjustment. You realize this on a bright sunny day

as you go into a movie theater and as you come out into the daylight again. We speak of the retinal adjustment as light adaptation and dark adaptation.

Suppose you enter a completely dark room after having been seeing in normal daylight. Within three minutes your eyes are 50 times as sensitive as they were at the beginning of dark adaptation. This much of a change can be attributed to the cones. Thirty minutes later your eyes would be 50,000 times as sensitive. This adaptation is credited to the rods.[3]

Under complete dark adaptation, for some reason people with brown eyes are about two times as sensitive on the average as those with blue eyes, and Negroes are more sensitive than white individuals. Brown eyes seem to be more deeply pigmented throughout and this may account for their somewhat better vision.[4] This fact would be very important in the selection of night drivers. Another very important discovery during the war was that, by wearing goggles with red filters, the process of dark adaptation could be hastened considerably.

Factors upon Which Color Vision Depends. We have seen how colors depend upon the nature of the stimulus, its prevailing wave length, its energy, and its degree of mixture, and also what structures in the eye are important for vision. The color we see depends not only upon the simulus, for the same stimulus gives rise to different colors at different times, but also upon the condition of the eye and brain at the moment they are stimulated. Certain phenomena of color which will now be mentioned are the result.

The Part of the Retina Stimulated. The same stimulus, if moved about before a stationary eye, will give rise to different colors at different places. To put the same thing in other words, a colored patch will change color as it moves about in the visual field. This is because the periphery of the retina is less sensitive to color than is the center, and it is less sensitive to some wave lengths than to others. This should not be taken to mean that the extreme periphery is completely colorblind, for if the light energy of the stimulus is great enough or if the patch is large

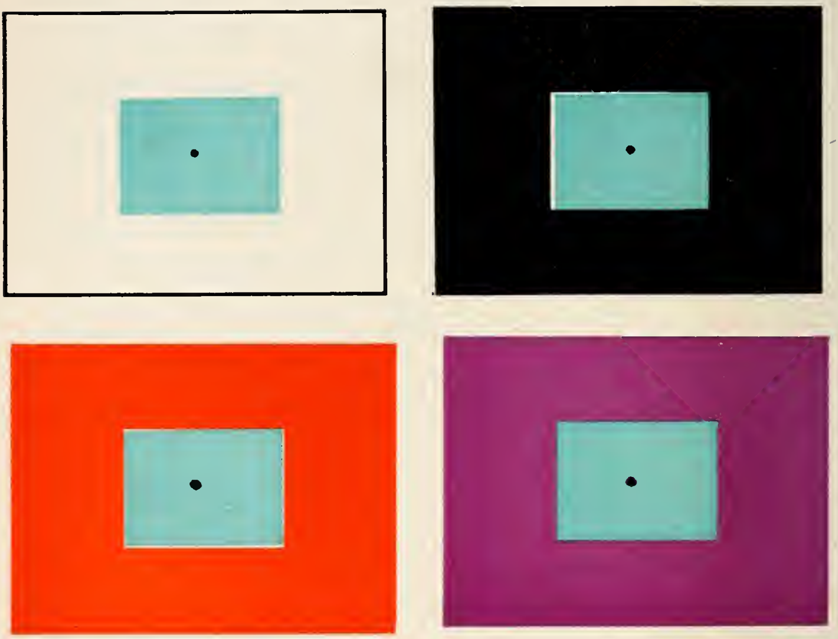


FIGURE 9.7. Color stimuli for illustrating negative afterimages and also color contrast. Stare at a dot in the center of one of the rectangles for about 30 seconds then shift your gaze to a plain white or gray paper and hold it. What colors do you see? Examine the four small rectangles. Are they the same color? Explain

enough, any hue may be seen out as far as one can see white or black.

The seeing of chromatic colors as such is attributed to the cones for the reason that they are most numerous at the fovea and become thinned out toward the edges of the retina. The rods give rise to only a few shades of gray, the lightest of which may have a bluish tinge. Both rods and cones distinguish differences in brightness, the rods for low degrees and the cones for high degrees. In darkness the fovea is therefore practically blind, since it has no rod vision. Therefore, if you want to see something in the dark, look slightly to one side of it.

Adaptation and Its Aftereffect. As one continues to look at a colored surface without moving the eye, changes immediately begin to set in, and continue as long as the same receptor cells are stimulated. Psychologically, the color loses saturation and in tint it tends toward a neutral gray. This change is hard to observe under ordinary circumstances, for we rarely let our eyes rest, unmoving, upon any object for more than a moment. The changes in chroma and tint are also so gradual as almost to escape detection. The process is one of local adaptation, to be distinguished from the general adaptation that occurs when the total surrounding illumination changes level. Suppose, after staring at a colored surface for half a minute, we turn our eyes upon a neutral gray background. There appears very soon a patch of color of the same shape as the original but of a color that is the complement of the original at which we started. The phenomenon is called a negative afterimage or negative aftersensation. It is negative in tint as well as in hue, that is, when the original is light the afterimage is dark, and vice versa. (See Fig. 9.7) .

The aftereffects of adaptation are noted in their purest form on a gray background, but they occur no matter what the following stimulation may be. Thus, after staring at blue we are yellow sighted, and anything following in the wake of the blue will be tinged with yellow. After red we are blue-green sighted; after black, white sighted, and so on. We do not ordinarily notice this in everyday life, even when the conditions are right for it, for in our effort to distinguish between the "real" and the "unreal"

we suppress and ignore afterimages. In fact, some students require an hour of practice before they can be brought to see their first afterimage. Occasionally, however, we may let afterimages distort our perception of the "real" colors. Everyone has often seen dark spots before his eyes after looking at the sun or bright lights.

Neighboring Colors: Color Contrast and Brightness Contrast. The general law of contrast is that any colored surface tends to tinge its neighboring areas with its complement. (See Fig. 9.7).

The phenomenon of contrast is very noticeable where colored lighting is used. Shadows cast by green spotlights are purplish; the slightly yellow sunlight gives bluish shadows on the snow which the average person misses but the artist puts into his painting. Contrasts must be taken into account in designing, dyeing, and decorating, lest the result when placing colors side by side be very different from that expected when colors are viewed alone.

The Effect of Individual Differences: Color Blindness. A light stimulus may arouse a red or green color for one person and only some shade of gray for another, or if any hue is aroused for him at all it may be yellow or blue. Such a person is said to be partially color-blind. There are even some individuals who see no hues at all. They are totally color-blind.

The partially color-blind see only two hues, yellow and blue. Some are more red-blind, while others are more green-blind. The defect is by no means equal in all individuals; some of them see red and green objects as such, if they are saturated enough. Ordinary color blindness should therefore be regarded as simply a reduced sensitivity.

According to results with the standard Ishihara test, about 8 per cent of American men and one per cent of the women are partially color-blind. The defect is apparently an inherited trait. It is said to be a sex-linked trait, that is, it goes with the hereditary determiner for the male sex but is transmitted through the mother and not through the father.

The prevalence of partial color blindness varies among the

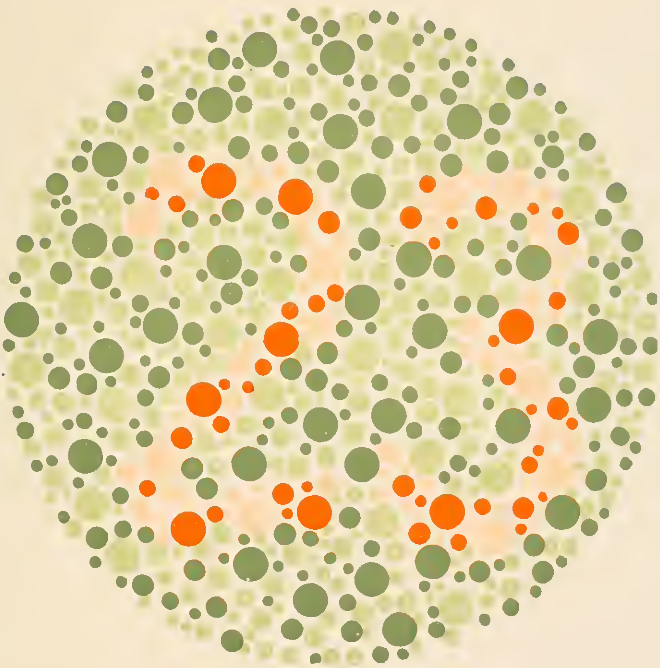


FIGURE 9.8. Sample of a color-blindness test. Persons with normal color vision see a number in this design; color vision defectives do not see the number. (Courtesy of the Scientific Publishing Co., Baltimore, Md., publishers of the Dvorine Color-Blindness Test.)

different races, the white race having the greatest proportion and the darker races the least.

While the fact of color blindness has been known for many years, little has been done to avoid errors that may result from the defect. Tests show that about 7 per cent of some groups of dry-goods clerks, painters, truck drivers, and 6 per cent of chauffeurs, when they have been sampled, are partially color-blind.[5,6]

The Known Object and Known Illumination: Color Constancy. Enough has been said already to show that there is not a perfect correlation between the light stimulus, its wave lengths, its energy, and its mixture, and the color seen, even by the normal eye. The color just preceding, neighboring colors, and the part of the retina stimulated all tend to interfere with that agreement between stimulus and conscious response. Still another factor that interferes is the fact that the individual often knows what color the object should be as seen under normal daylight illumination, and he is strongly inclined to see it that way no matter how much the stimulus light coming from it may change. This phenomenon is called color constancy.

Snow is white; coal is black; blood is red; and grass is green. They tend to remain so for us in spite of gross changes in the actual stimulus. Snow in a deep shadow may reflect less light energy than coal that is lying in the noonday sun. Both should look gray if the brightness we see corresponded exactly with the amount of energy of the stimulus. The black letters on a printed page look black under the noonday sky although they reflect more light at that time than does the white page in the deepening twilight. The grass continues to look green with little change in tint in spite of changes in illumination. A red book likewise keeps much of its crimson hue whether seen in full yellowish lamplight or seen under a deep bluish shadow.

Not only familiar objects are seen in their characteristic colors. Choose a sample of paper, gray or colored, unknown to a friend, and he will see it more nearly in its "correct" color than near its stimulus value even though it is shown to him under unusual lighting, provided that he can sense that unusual illumination. Confuse him as to the kind of illumination and he sees some-

thing different. For example, let us say that you have placed a light gray paper inside a box. Unknown to him, red light is shining on the paper, and red alone. You ask him to view the paper through a hole in a card. He will see a "film" color, red in hue.* This corresponds more nearly with the actual stimulus affecting his eye. Remove the card, letting him view the paper directly. He is now able to separate object from its illumination, and making allowances for the illumination he sees the object in its normal color.

We are perpetually making corrections of this sort, automatically, unconsciously. There is no reasoning involved. Even very young children and lower animals such as chicks and fishes have been found to make the same kind of adjustments in color. The seeing mechanism apparently detects the nature of the general illumination separately from the objects that it senses through that illumination.

It is such automatic "corrections" as this that make things so difficult for the amateur color photographer. His camera will give color results not exactly as he sees the scene but as illuminating conditions and reflecting conditions dictate. Any departures from this are due to the adjustments of his camera and any selective peculiarities of the film.

Summary

The colors we see are generated by activity of the brain, and colors, as such, thus become subject matter for psychology. Colors can be specified by naming their hue and by indicating their level of brightness and degree of chroma. All the colors we can see fall into an orderly system known as the color solid.

Seeing colors in the normal manner requires stimuli in the form of light waves and the response of the eye and brain. Light waves vary in length, the longest visible ones giving rise to red and the shortest to violet. Light waves also vary in amount of energy; the greater the energy, the lighter the color. Most objects reflect a mixture of wave lengths. The prevailing wave length

* Film colors are unattached to objects, for example, the blue of the sky. They are distinguished from surface colors which are attached to objects.

determines the apparent hue, and the more complete the mixture, the less saturation or chroma in the color.

The eye is a camera-like mechanism devised to focus the light rays from the world in front of us, upon the retina at the back of the eyeball. In the retina are many millions of receptor cells. Some receptor cells, the rods, respond only to very weak lights, and so are adapted to seeing in twilight and darkness. The other receptor cells, the cones, respond only to medium and strong lights. Rods give us distinctions only between light and dark, while cones give us color vision.

While the wave length of the stimulus usually determines the hue of the color, and the amount of energy determines the tint, a number of factors disturb these relationships. The hue and tint of a color also depend upon the illumination, the part of the retina stimulated, the duration of the stimulus, the preceding stimulus, and the neighboring stimulus. The color seen also depends upon the person seeing it, whether he is normal or color-blind, upon what he knows about the object, and upon what he can sense about the nature of the illumination under which the object is seen. We tend to see objects in their most natural colors, as when viewed under normal daylight illumination, no matter where they are or what conditions obtain at the given moment.

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CHAPTER X

Seeing: Forms, Space, and Movement

Problems of Sensory Organization

Bringing Order Out of Chaos. When a complex receptor like the eye is stimulated, each one of several million receptor cells responds to the energy acting upon it. Each one, more or less independently, sends impulses to the brain, and there excites its own corresponding elements. How do the impulses initiated by one visual object, one speaking voice, one tactual pattern, get together again as a unit? What separates one visual object from another, and one speaking voice from another? How are the messages arriving in the brain unscrambled and decoded?

Referring to visual perception,* one writer has expressed the problem in these words: "The eye sees a mosaic, the brain a continuous picture." This point is illustrated in the typical newspaper cut or television picture. Magnify any picture in your morning newspaper and you see something like Fig. 10.1. What appears to be a continuous gray or black surface in the unmagnified cut stimulates your eye as a mosaic. The same kind of smoothing-over process to make homogeneous surfaces is going on in vision all the time, since the cones of the retina, although packed tightly together, have spaces between them.

* "Perception" is a general term which means becoming aware of things and conditions in the world about us at the moment through the use of the senses.

Alternative Organizations Often Possible. Most persons have been perceiving objects all their lives, and they are likely to take their powers of perception very much for granted. It seems the most natural thing in the world that upon opening our eyes familiar objects should stand there before us. The process of perception presents no mysteries to the average person. It is only when two people disagree upon the perception of something that they begin to realize that the process is, after all, a very subjective one. But even in this case, each person is likely to think that his own perception is correct; that it duplicates the real thing, and that the other person is defective.

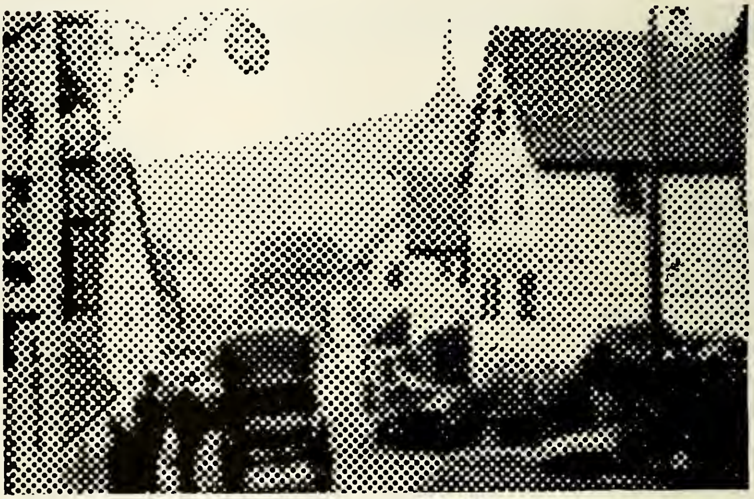

FIGURE 10.1. A typical newspaper cut, magnified. (Adapted from W. Metzgar, *Gesetze des Sehens*.)

Most of us are willing to admit that occasionally our perceptions do not fit the real facts, for we catch our senses in error. But how many times are we in error without realizing it? And how many times do a number of individuals fall victim to the same error, none of them realizing it because they uphold one another in their common error. Fig. 10.2 is a familiar type of picture often found in newspapers and magazines. You can no doubt find the hidden objects. But remember that as you do so the stimulus pattern itself has not changed one iota. You are simply reorganiz-

ing the same pattern of stimulation into another mental configuration.* Elements that formerly belonged to one familiar object must be torn loose and regrouped in another manner during the process. The emergence of the new organization is usually very

FIGURE 10.2. A puzzle picture. Find the concealed buffalo, two deer, and a bear. (From *Child Life Magazine*, Copyright 1937 by Rand McNally and Company.)

sudden; very few if any halfway steps are observable. Though we may be faced with situations in which confusion seems to reign at first, the general rule is that some kind of order prevails, at least the best order of which we are capable.

* The German term "Gestalt" is often used in this connection, in place of "configuration."

Ambiguous Figures. The objects in Figs. 10.3 and 10.4 provide stimuli that yield two or more different organizations, each one about as "correct" as the other. Such diagrams are known as ambiguous figures. Stare at the cube continuously for a minute or two and note the shift back and forth from one pattern to the other. First one square is seen in front and then the other. After one sees the first shift he is likely to see about 20 per minute, as does the average person. There are decided individual differences in this respect. Some see as few as one or two per minute, or even none at all, and others see as many as 150. The rate of fluctuation is controllable to some extent; it can be made to change more or less often.

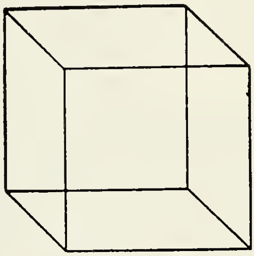

Figure 10.3. The outline cube. Which square is in front, the right or the left one? Just wait and the other will come forward.

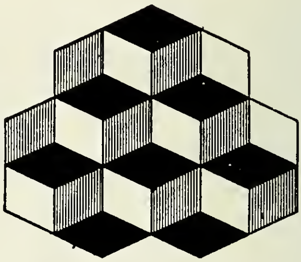

Figure 10.4. How many blocks are there? Count them again.

Principles of Visual Organization

In dealing with sensory organization we are interested, first, in the laws of grouping; for perception proceeds by combining separate excitations into larger wholes. Perception also proceeds in the opposite direction, of differentiating smaller wholes out of larger masses. The two processes may be called by the familiar terms, synthesis and analysis. We will deal first with synthesis. The synthesis of impulses received from single receptor cells has already been mentioned. There is also synthesis of larger "blocks" of excitation, which we are better able to demonstrate.

External Determining Factors for Grouping. Four of the more important external factors that force certain groupings are

given here. They are called "external" because they are conditions of the external stimuli.

(1) *Contiguity.* Excitations that occur close together either in time or in space are likely to become one. In Fig. 10.5a you are almost compelled to see seven diagonal lines rather than five horizontal lines. There is a strong cohesion between dots near to each other that ties them together. A succession of taps given in iambic or trochaic rhythm, or even without rhythm, marks itself off into groups. In this case it would also be very difficult to tear

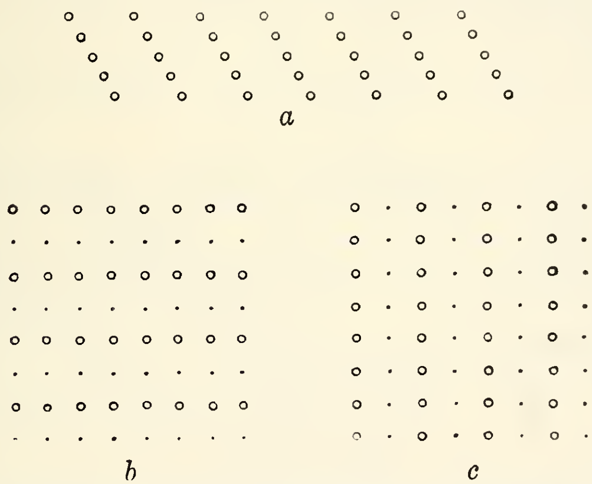

FIGURE 10.5. The factor of contiguity, illustrated in *a* and the factor of similarity illustrated in *b* and *c*. Can you see horizontal rows in *a* or vertical rows in *b*? (After M. Wertheimer.)

the objective grouping apart and to create another subjectively determined grouping. Telegraphic messages consist of a series of natural groupings. We can say that, other things being equal, *the nearer together two excitations come in time or in space, the more likely they are to be held together in a larger whole.*

(2) *Similarity.* Excitations that resemble each other in some way are more likely to be unified than are unlike excitations. In Fig. 10.5b we are almost forced to see horizontal lines, and in Fig. 10.5c to see vertical lines. In the two cases the factor of contiguity is held constant. Contiguity favors neither organizations here, though, of course, it favors some organization.

The similarity may be of various kinds; quality, intensity, size, or form, as in Figs. 10.5b and 10.5c. The common factor may be one of movement, in the same direction or at the same rate, or it may be a common meaning or use.

(3) *Continuity.* Fig. 10.6 is at first a meaningless collection

FIGURE 10.6. The factor of continuity. A word is concealed in this figure. Can you find it?

of lines, though it is probably seen as eleven units rather than a larger number of single lines. Cover the upper half of the figure, and the lower half then becomes a meaningful word. It was hidden before for most individuals because of the continuity of the lines that compose the letters. In order to see the letters separated from their contexts a little perceptual analysis is necessary. Where continuity prevails there is a general tendency for us to see larger, more inclusive objects first.

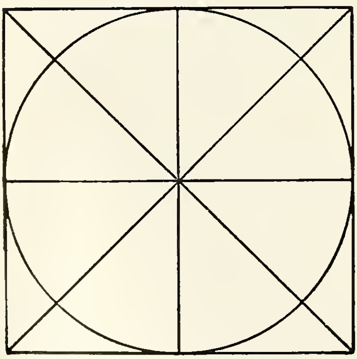

FIGURE 10.7. The factor of closure. All the letters of the alphabet are concealed in this diagram. Can you find them? You will have to distort some of them somewhat.

(4) *Inclusiveness and Closure.*—The same general principle applies to Fig. 10.7. At first glance one sees simply a regular geometric patern of a rather conventional design. It is one object, set out against a plain white background. It is symmetrical and balanced; a good stable struture. All this conceals the very familar letters that may be seen by analysis within it. In fact, all of the letters of the alphabet can be isolated from among the lines that compose the figure.

When any object of perception becomes more or less segregated or closed off from everything else, we have the phenomenon of *closure.* Incomplete objects, like a broken triangle. hand, or human face, are often seen as completely whole, the gaps being glossed over. More often than we realize stimuli leave gaps that the brain somehow fills in, just as it fills the more minute gaps between the excitations of single receptors. All these are cases of closure. In proofreading, the average person overlooks entirely missing letters or substituted letters in familiar words, partly because of the factor of closure. Three typographical errors were left purposely in the preceding paragraph. Did you observe them?

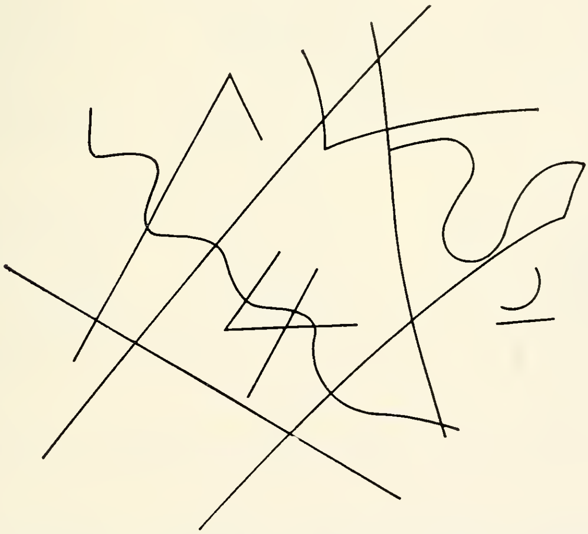

FIGURE 10.8. The factor of familiarity. How many meaningful objects emerge from the mass of lines in this diagram?

Internal Determiners of Grouping. The two important internal factors for grouping are familiarity and mental set. They are called "internal" because they are conditions of the organism.

(1) *Familiarity.* It has already been stated that new organizations can be learned, and once learned, they make easier the perception of the same pattern in the future. Once you find the hidden objects in any of the figures on recent pages, it is very much easier to see them again, and, indeed, it may be difficult to

lose them. In Fig. 10.8 the only object that stands out immediately is the number "4" near the center.

While familiarity with a certain pattern undoubtedly helps in bringing that particular pattern to light again, even extreme familiarity will not always bring results, if competing factors are too strong. This was true in Figs. 10.7 and 10.8, where very familiar letters failed to appear without the added internal factor of mental set. In Fig. 10.8 there are at least three additional "4" 's that are usually overlooked because of the factor of continuity.

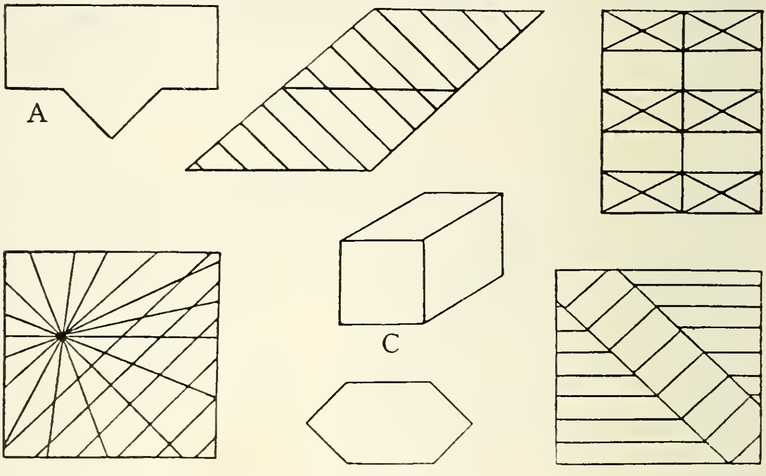

FIGURE 10.9. Can you find objects A, B, and C concealed in the other figures? Mental set helps you in this. (Adapted from K. Gottschaldt.)

Gottschaldt showed the utter weakness of familiarity, in opposition to the external factors of continuity and inclusiveness, by means of drawings like those in Fig. 10.9. He exposed simple forms like A and B from 3 to 500 times for his subjects to see. Then he later exposed more complicated closed figures in which the simple ones were concealed. In some instances only one person in five could find the hidden figures even with instruction to do so and after a diligent search. When not instructed to look for the simple figures, less than 2 per cent of them were seen at all.[1]

(2) *Mental Set.*—By now it should be apparent that mental set is a very potent factor and without it the factor of familiarity is rather ineffective. But in the face of strong external factors

mental set has to give way, except in those rare individuals who, lacking a sufficient sense of reality, are able to mold the world to suit their own desires. Mental sets determining observation originate in the motives operating at the moment.

Figure and Ground. Every organized object appears set off against a background. It acquires a boundary line that encloses it, much as a living organism acquires a skin. This is a process of analysis. The formation of boundary lines is an interesting problem in itself. It is one thing to see colors; it is another thing to obtain sharp division lines between them.

Sit in a dark room and look at a dark, uniform screen upon which is projected a patch of light in the shape of a triangle. When the light is very weak the patch is vague and shapeless. Only when the intensity of the light is great enough can you grasp its triangular form, and after that there must be a further increase in strength before you get a distinct outline. It requires about 15 times as much light to recognize the form as it does to see any light at all, and about 25 times as much to see distinct outlines.[2]

Boundary Lines. An essential condition for producing lines is a strong brightness contrast between neighboring colors. If the two are equal in brightness, even though they differ in hue, it will be difficult to distinguish between figure and ground. The boundary line is vague and indistinct. Blue and green blur into one another most, and blue and red least. The legibility of letters of one color appearing on a background of another color depends upon the amount of contrast in tint (brightness). From this it might be supposed that the combination of black and white would give the best legibility. But, with the same amount of contrast in tint, the legibility of a blue-white combination or of a black-yellow one is slightly greater. This adds some contrast in chroma to the contrast in tint already present. In the case of a black-white combination, black on white is more legible than white on black, because of a tendency for a white area to become slightly diffused as it encroaches upon its black neighbor. Manufacturers of license plates on motor vehicles sometimes fail to take account of these facts.

Properties of Figure and Ground. A well-known example of figure and ground is the Rubin goblet as shown in Fig. 10.10. In

this picture either the white faces or the black goblet may become figure. If one maintains a passive attitude, first one is figure and then the other. Mental set is a strong factor here and can prolong either goblet or faces as figure. Notice that the boundary line belongs to the figure and encloses it like a skin. The figure color is a hard, surface color and becomes a "thing." The ground color

FIGURE 10.10. The goblet figure, illustrating figure and ground. (Adapted from W. Metzgar, *Gesetze des Sehens*.)

is more of a soft, yielding color and is not a thing but simply background. Correlated with these introspective facts there are undoubtedly brain activities, one type of action corresponding to the properties of the figure, and another type of action corresponding to the ground.

The ground tends to recede back of the figure and to take on a homogeneous color. Objects in the region of the ground that otherwise might stand out are more or less swallowed up in the ground. This is probably responsible for our overlooking many objects in the visual field. Who has not had the experience at the dinner table of calling for the salt shaker, or for a knife or fork that he thought had not been provided, only to be told that the salt shaker is right before his eyes or that the eating equipment has been there all the time?

Camouflage, Natural and Otherwise.—Lower animals as well as man depend upon the facts of sensory organization and of figure and ground, often using them as protective devices. The zebra's protective coloration should often be effective. His vertical stripes blend with the vertical stripes of light and shade when he is among the tall grasses. When in the clutches of an enemy, the uncertainty of his true boundary lines should make grappling him difficult.

A giraffe's dappled tans melt into the general "ground" of sunlight filtering through trees and of spotted, tan-hued grassy plain. Birds' eggs that are laid on the ground are speckled to resemble stones and sand. Birds that nest in tall grass are speckled and striped until almost indistinguishable from their surroundings. The birds in Fig. 10.11 are good examples. Lower forms, including some fish and amphibians, have the power to change the color of their skins to conform more nearly with the ground upon which they rest for the time being. This is known to be a nervous reaction, which is to say, a mental one, although probably not a conscious or intentional one.

The human practice of camouflage is based upon the same principles. The painting of ships, trucks, and guns with large blotches differing in color, has the effect of obscuring the real outlines and of introducing new ones where no real boundaries exist. The colors are similar to the blues, greens, tans, and browns of sky and landscape.

Visual Acuity. Another problem of visual analysis has to do with how small a gap may be seen between two objects such as dots or lines. You might say that this represents the lower limit of continuity. It also represents the limit of visual analysis, for there are details so fine that the unaided eye cannot discriminate them. This is the problem of visual acuity. It is basic to the size of print that we can read.

All of you who have had your eyes examined are familiar with the traditional letter charts with letters ranging from large to small. If you can read letters correctly at a distance of 20 feet that the average person can read, your vision is said to be 20/20. Vision is 20/30 if one can just read at 20 feet letters that should

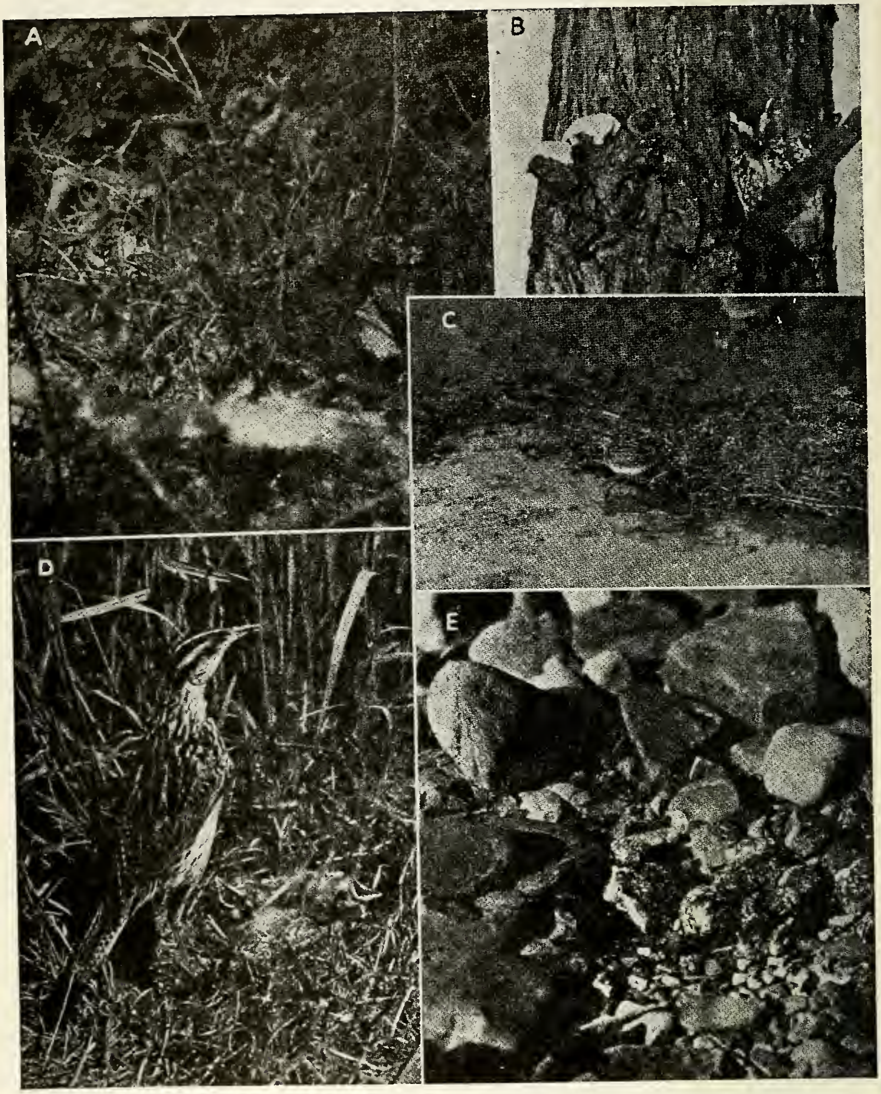

Figure 10.11. A study in protective coloration. A. Ruffed Grouse on nest showing dead leaf and twig pattern. B. Bark pattern of Screech Owl. C. Drift pattern of Pectoral Sandpipers. D. Grass pattern of Meadow Lark, startled while at its nest. E. Pebble pattern of young Kildeers. (Courtesy of Arthur Allen, *The Book of Bird Life,* D. Van Nostrand Co., Inc.). Military camouflage also destroys outlines by making objects appear continuous with their backgrounds.

be visible at 30 feet. A new type of visual-acuity test uses a ring with a very narrow gap such as in Fig. 10.12. The ring is turned to different positions and the person being examined reports the position of the gap. The width of gap and size of ring are varied.

With a stimulus composed of two black dots on a white

FIGURE 10.12. One type of test of visual acuity. The examinee is to tell where the gap comes in each ring.

surface, the gap must be such that it covers a distance of about 0.004 mm. on the fovea if we are to see two dots. With smaller separations we are likely to see only one dot. Outside the fovea, a gap must be larger than 0.004 mm. for discrimination. In the fovea this means that at least one cone must come between the ones stimulated with the dots, for each cone is about 0.004 mm. in diameter.

SOME ERRORS OF VISUAL PERCEPTION

We often make mistakes of various kinds of seeing. There are some common errors all of us make most of the time in the perception of visual forms and patterns. They are so common they are called *normal illusions*. It is often worth our while to know of their existence so we can be on guard against them. Illusions, even though they are false, are nevertheless perceptions. They obey certain laws of observation. They are also interesting from this point of view.

Illusions of Contrast. One class of illusions comes under the principle of contrast. The contrast may be either simultaneous or successive.

Illusions of Simultaneous Contrast. Fig. 10.13 contains some self-explanatory patterns. The same object among larger ones seems smaller than when among smaller ones. There is a general principle of relativity in observation. The size of an object is relative to the size of others among which it appears.

Illusions of Successive Contrast. There are also negative

aftereffects of many sorts. Look steadily at a heavy, curved line about 30 centimeters long for a few minutes. Then look at a straight line. The straight line now becomes bowed slightly in the opposite direction. While staring at the curved line the brain seems to be adapting itself to the curvature, which diminishes slightly. Adaptation, however, is never complete. The same thing is true for lines tilted from the true vertical or horizontal position. Staring at tilted lines causes the vertical to shift in the opposite direction slightly.

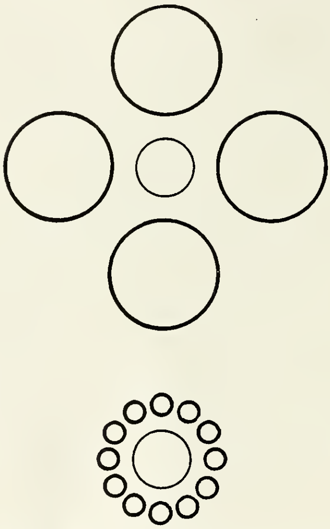

Figure 10.13. An illusion of contrast. The central circles are actually of equal size.

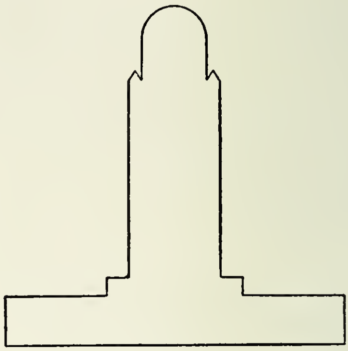

Figure 10.14. An illusion of vertical versus horizontal distances. The vertical distance, from base line to tip of the dome is drawn exactly equal to the length of the base line.

Some Geometric Illusions. Numerous geometric illusions showing distortions of size and shape, and of direction of lines, are frequently met in everyday life. A few principles can be recognized, and they will now be illustrated. The following list of illusions is not at all complete, but it includes the more common ones.

(1) *Vertical distances* seem longer than horizontal ones of the same length (see Fig. 10.14). This illusion is an item of importance in architecture and designing as are many of the other illusions to be mentioned.

(2) *Broken or interrupted spaces* seem larger than continuous or unbroken spaces (see Fig. 10.15). The open basement of a new house under construction seems disappointingly small. When

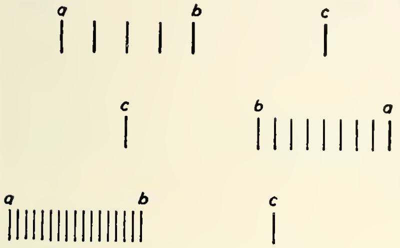

FIGURE 10.15. An illusion of interrupted spaces. The distances *ab* and *bc* are made exactly equal in all cases

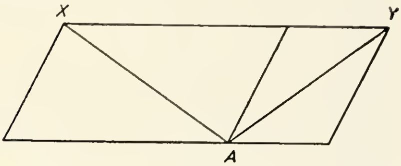

FIGURE 10.16. The two diagonals *AX* and *AY* are drawn exactly equal.

divided into rooms, the house seems a little larger, but each completed room seems small until its floor is interrupted with furniture and its walls with wallpaper and pictures.

(3) Sometimes the *part of an object is falsified because of the whole in which it appears.* In Fig. 10.16 the two diagonal lines, although drawn equal, take on the property of size from the larger wholes in which they appear. They thus appear decidedly unequal.

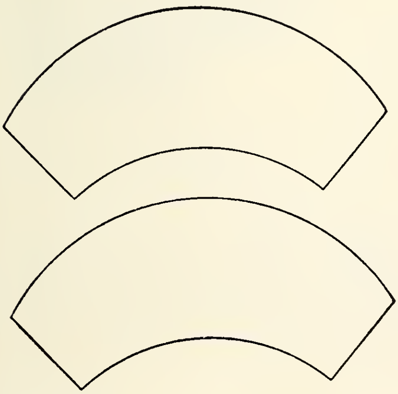

FIGURE 10.17. The two sectors are drawn exactly equal in size.

(4) Sometimes the reverse takes place. *The whole may be judged according to some emphatic property of a significant part.* In Fig. 10.17, the two segments seem different in size because the neighboring sides are contrasting in size. This same principle applies to the well-known effects of stripes. Vertical stripes in clothing enhance height and slenderness, whereas horizontal stripes enhance girth, as every observing person knows.

(5) *When lines cross another line there is a bending effect.* The horizontal lines in Fig. 10.18 are drawn parallel, but they seem to be converging and diverging. The general principle is that acute angles tend to be seen larger than they are and obtuse angles tend to be seen smaller than they are. You might conclude from this that an angle of 90 degrees would seem just right, being neither underestimated or overestimated. In tests with children aged 14 to 18, however, the angle not distorted in either direction was that of about 80 degrees.[3] Fig. 10.19 shows that the bending effect also applies to curved lines.

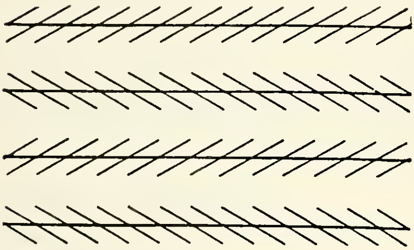

FIGURE 10.18. The angle illusion. The horizontal lines are drawn exactly parallel.

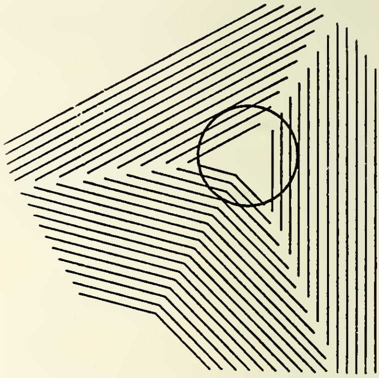

FIGURE 10.19. The circle was drawn exactly circular.

Color and Apparent Size. Lighter objects look larger than darker objects of the same size. White, yellow, and green objects ordinarily look larger than red, blue, or black ones. Most women know that to keep that small-appearing figure they must not wear white.

Visual Space

Sensory organization involves more than the discrimination of figures from their grounds and the grouping of parts into wholes. It would not be complete without the arrangement of objects, including the organism itself, and events in space

and in time. The body itself has a spatial arrangement that the individual comes to know. In a sense, every organism is a naive anatomist to the exent that it becomes acquainted with the arrangements of its own parts. The arrangement of other objects is organized with reference to one's own body, and the objects with reference to each other. In order that one may get about within his environment, he must have at least a fair appreciation of its layout.

The General Frame of Reference. The organism's primary concern with space is the correct location of stimuli. This involves both direction and distance. Several senses cooperate in building up a spatial framework within which stimuli can be placed. Most accurate of the senses is vision; next is touch; then, probably, come kinesthesis and audition. But all depend directly or indirectly upon kinesthesis for their frame of reference. Our conception of up and down, the axis about which the practical framework actually hangs, depends largely upon the muscular sense, and, to some extent, upon the static sense. The force of gravity is responsible. In attempting to stand upright we are forced to orient ourselves with reference to this force.

This helps to establish our vertical dimension. A second dimension, the horizontal, is determined by the fact that in general we are bilaterally symmetrical. Things are located as right or left with reference to the two halves of our bodies. The third dimension arises from the distinction between front and rear. Our space world, as we think of it, but not necessarily as we perceive it, is a three-dimensional world. Had we been creatures of another kind, more exempt from the influence of gravity, like some water animal, or having several arms rather than two, like a starfish or an octopus, our conception of space would probably be very different.

Visual Localization. What factors give us the correct direction of a visual object? Through the lens system of the eye, the physical image of external scenes is projected completely inverted, but in a systematic arrangement, upon the retina. When the eyes and head are turned so as to look straight ahead, we easily describe

points in the visual field as being high or low and right or left. If we turn our eyes to the right, the relative positions of things remain the same on either retina, but what was before directly in front is now to the left of the fixation point. But it is still located as directly *in front of the body,* which is the important, adaptive result. The brain makes an allowance for the turning of the eyes. Thus, when the eyes turn in their sockets the perceived world remains stationary.

Even when the head turns along with the eyes the visual world remains oriented as it was with respect to the body, though it may appear to shift slightly. When the body moves from one place to another, changing the visual field more decidedly, we piece together successive visual fields into one unified picture. The relations among objects in one's visual field, and their relations to the vertical, are kept relatively constant, except under unusual conditions, for example, when one is lying down or standing on one's head, or after one has been whirling around for a few turns.

It can be seen that the stimulation of a given point on the retina does not always produce a sensation localized in any absolute direction from the body or from the head. It *does* produce a sensation seen in a given direction from the *axis of the eye.* The axis of the eye is a straight line drawn through the fixation point and the fovea. A point of light is usually seen "projected" out along the line drawn through the point stimulated and the "nodal" point in the eye (see Fig. 10.20a.). When prisms are worn like spectacles, inverting the image on the retina (making it right side up), the individual sees the world turned upside down. After a few days he becomes well enough adapted to this arrangement so that he can reach upward when it looks to him as if he should reach down, and walk upstairs when it looks as if he should go down. But even then, the world still seems inverted visually as compared with his tactual and kinesthetic world, which retains its familiar orientation.

It is likely, then, that the association between the direction an object is seen from the eye and its stimulated point in the retina is a very thoroughly established one and hard to disrupt. The fact that the physical image on the retina is inverted, and that we still see things in an upright position, is no unusual mystery. The

image on the retina is on a cup-shaped surface, while on the cortex of the brain the excitation takes on a very irregular shape as it conforms to the much-folded cortex. Yet we do not see things correspondingly distorted. Remember that the brain tends to make the perceived world conform to reality in spite of the way in which it receives its excitations.

Seeing Visual Size. The primary factor for perceiving the size of an object is the size of the retinal image. And this depends upon the *visual angle* that the object occupies. The nearer the object the larger its visual angle (see Fig. 10.20, b and c). An object that recedes from us should grow smaller according to the shrinking visual angle. For a familiar object like a man, this is not quite true; its apparent size grows smaller less rapidly than

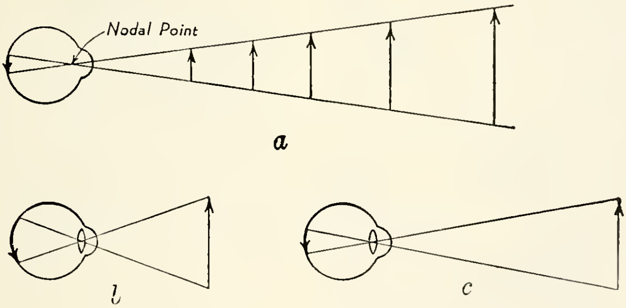

FIGURE 10.20. a. An image of fixed size on the retina may result in a visual object of increasing size as it is seen projected farther from the eye. The visual angle is constant. *b* and *c*. An object actually farther away fills a smaller visual angle and causes a smaller image on the retina.

the stimulus does. There is a compromise between the "real" object and the "stimulus" object. The phenomenon is called *size constancy.* The sun and the moon always look larger than their visual angles justify. The tip of your little finger held at arm's length before the sun will completely cover it.

An Illusion of Visual Size. Size and distance are somewhat interchangeable cues. Sometimes we cannot tell whether a certain object is a small one nearby or a large one at some distance from us. If we have information about size, distance can be estimated, even though roughly. If we have information about dis-

tance, size can be estimated. If we lack information about either, we often make wild estimates.

Seeing Distances of Objects. The relative distances of objects from us are perceived by the use of various factors. Obviously, a flat stimulus pattern spread out on the retina contains no depth in it, no more than does a painting or a photograph. Yet there are

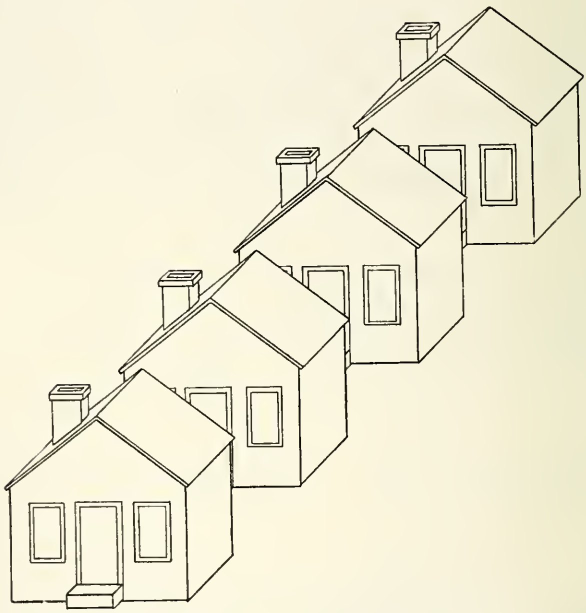

FIGURE 10.21. The factor of interposition. Which house seems nearest?

factors in the stimulus pattern itself that suggest to the brain what objects are near and what ones are farther in the background. Seeing the world as having depth, or the third dimension, is a task for two eyes working together. But one can judge an object as being nearer or farther than another without actually seeing the solidity of the space they occupy. These factors a one-eyed man depends upon, though his judgments of distance are far inferior to the normal. Try, for example, to bring the tips of two pencils held one in each hand at arm's length, together in front of you with only one eye open.

Monocular Factors for Visual Distance. The following factors are called monocular because they are useful for one eye alone, but they operate for two eyes as well as for one.

(1) *Interposition of Objects.* Objects with more complete outlines are nearer than those with only partial outlines (see Fig. 10.21).

(2) *Linear Perspective.* The fact that remote objects occupy a smaller visual angle than near ones lends a very dependable cue to the perception of distance. In Fig. 10.22 there is no question about which telephone poles are nearest.

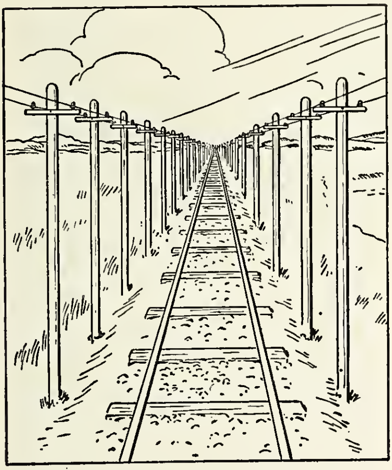

FIGURE 10.22. Linear perspective.

(3) *Aerial Perspective.* Distant objects have blurred, hazy outlines and near ones have sharper, clearer ones (see Fig. 10.23). This is partly due to the greater amount of air between the observer and distant objects, with its water vapor and dust particles to diffuse the light waves. It is also partly due to the poorer visual acuity for details at distances where details occupy smaller visual angles. An illusion based upon this factor may be seen in the Rocky Mountains where the air is relatively free from vapor and dust and the sharply-cut stone contours 40 miles distant seem within walking distance. In the mountains near industrial cities, where the air is charged with smoke and vapor, nearby mountain tops, with blurred outlines, seem miles distant. Another cue resulting from the aerial effect is the bluish tinge cast over distant horizons.

(4) *Light and Shade.* More than we realize we perceive the solidity and depth of objects, the hollows and protrusions, on the basis of shadow effects. Artists make full use of this factor to produce realistic effects in such objects as vases, faces, fruit, and the

like. Photographers are even more adept in making artistic use of this factor with elaborate preparations of their models. Fig. 10.24 is a very effective illustration.

(5) *Parallax.* Close one eye, look at an object in the middle foreground and move your head from side to side. The effect is

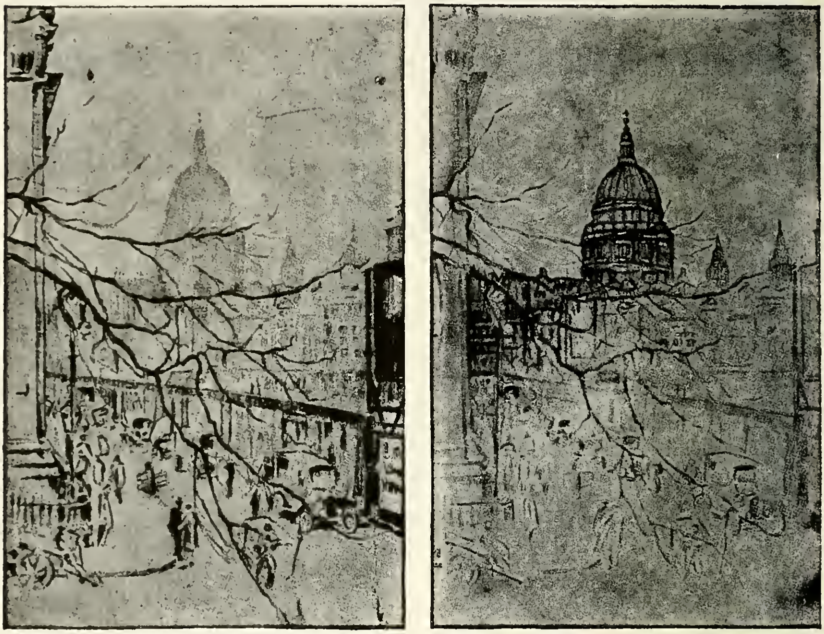

FIGURE 10.23. Two views illustrating aerial perspective. In which one is the dome apparently farther away? (From the Meier-Seashore "Art Judgment Test," courtesy N. C. Meier.)

that more distant objects move in the same direction as your head is moving and near ones in the opposite direction. The relative movement of objects as the eye changes position is due to *parallax.* In ordinary observation our heads are rarely stationary. Even a slight jostling of the head is sufficient to give some parallax. Although there is little apparent depth in the average motion picture or television picture, except for what the previous factors can suggest, the use of parallax adds much to the illusion of depth. This is accomplished by having the camera move slowly before the scene it is taking.

(6) *Accommodation.* For more distant objects the lens of the eye flattens in focusing the image sharply on the retina as the ciliary muscles relax (see Fig. 9.5). For near vision the lens

FIGURE 10.24. The factor of light and shade. A meteor crater in Arizona. Turn your book upside down. (Courtesy of the Western Air Express and McGraw-Hill Book Company, Inc.)

becomes more rounded as the muscles contract. It has been suggested that the feeling of muscular strain going with accommodation, or at least the kinesthetic impulses coming from the ciliary muscles, may furnish cues as to the distance of an object. When

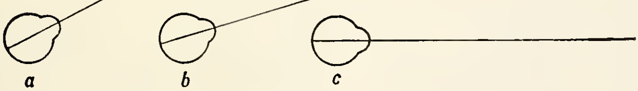

FIGURE 10.25. Three degrees of convergence of the eyes.

all other cues are eliminated as well as they can be, there is some ability to discriminate distances, but this is probably limited to a range from a few inches to two or three yards. In the presence of better cues it is probably little used.

Binocular Factors for Seeing Distance and Depth.

(1) *Convergence.* In looking at an object of interest the two eyes turn upon it so as to bring the object upon the foveas of both retinas. For near objects they are turned more inward, and for distant objects they are turned almost parallel (see Fig. 10.25). Corresponding to each setting of convergence is some pattern of kinesthetic stimulation. Whether conscious or unconscious, the effect of this is to furnish the brain with information concerning distance. This factor is about three times as effective as that of accommodation, but it is probably of no use beyond 20 meters.

(2) *Retinal Disparity.* When the two eyes gaze at the same solid object, they do not obtain the same identical view of it. Two different patterns of excitation are sent to the same set of neurones in the brain. Each pattern taken alone would give only a flat picture of the object. But in the fusing of the two slightly different patterns of excitation in the brain the effect of solidity and the third dimension comes to life. Two separate patterns of excitation, neither having in itself the property of solidity, in coming together gain that property. Hold a closed book at arm's length with its edge toward you. Close one eye, then the other, and note what kind of view you get for each eye alone. Then open both eyes and note that the two views form a composite, but that this composite has something that either view alone lacked, namely, a realistic bulk. Your two views and the solid one look something like those in Fig. 10.26.

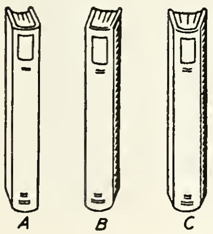

FIGURE 10.26. How the two eyes cooperate in seeing depth. View *A* of book is seen with the left eye alone; view *B* of book is seen with the right eye alone; and view *C* is seen with both eyes. (From A. R. Gilliland, J. J. B. Morgan, and S. N. Stevens, *General Psychology*, D. C. Heath and Company.)

The Stereoscope: The proof of the importance of retinal disparity is definitely shown by the use of the *stereoscope* (see Fig. 10.27). Two ordinary flat drawings or photographs are made of the same object or view. If drawings, the views are as though seen with right and left eyes alone. If photographs, two different views are taken with the lenses of the camera as far apart as the normal distance between

the two eyes. Placed in the stereoscope so that each eye has only the view intended for it, they give a very realistic depth effect. Stereoscopic motion pictures have been produced by making a red view for the right eye and a blue-green one for the left, the two being shown overlapping on the same screen. Filters held before the eyes, red for right eye and blue-green for left, give each eye alone its own view. The results are very striking.

Is There a Special Sense of Space? Sometimes lower animals and even men do remarkable things in finding their way about. The prompt and unthinking conclusion is that they possess some mysterious power to know directions. Cats and dogs find their way home after being carried blind for hundreds of miles. Birds migrate with the seasons for hundreds of miles. Bees find their way back to the hive, though far from home. Men lost in the woods follow a "hunch," and reach safety.

When experiments have been performed on this point, it is found that, without ordinary sensory cues, there is no appreciation of direction.[4] Birds have excellent vision, and, flying high, can survey miles of landscape. Even carrier pigeons cannot find their way back to the home cote unless they have seen the landscape before the trial flight. Primitive man gets lost in the jungle just as easily as civilized man if he loses familiar landmarks.

Visual Movement

Perception of Real Movement. The stimulus necessary for the normal observation of movement is an excitation moving across a sensory surface, such as the retina or the skin. Movement can only be given then, by the cooperation of receptor cells that are stimulated in succession. This holds true for receptors in the skin, the retina, and in the joints.

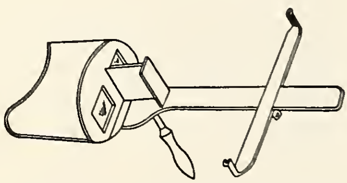

Figure 10.27. Brewster's prism stereoscope.

Judgment of Speed. There are limits to perceived speed. The second hand of a watch can be seen in motion but the minute hand cannot. At 2 meters from the eyes the slowest perceptible

movement is about 2 mm. per second. The upper limit to perception of movement is appreciated by the fact that we cannot see flying bullets and the like.

The farther away an object is, the slower its speed seems. The judgment of correct speed and of differences in speed is all-important to drivers of modern motor vehicles, as well as to luckless pedestrians. Many an accident is due to misjudged rates of speed. The ability to judge speed, like most powers of perception, is open to improvement with practice, but tests show much weakness in this respect and illusions are numerous.

Illusions of Movement. Among illusions of movement are impressions of movement in stationary objects, apparent lack of motion in objects really moving, and illusions of speed.

(1) *Negative Afterimage of Movement.* Stare for a few seconds at a waterfall, then fixate a wall of rock beside it. In the part of the visual field formerly occupied by the waterfall you should see a vivid, flowing movement in the opposite direction.

(2) *Referred Movement.* Who has not seen the moon flying fast behind clouds that half conceal it? Close observation shows that the clouds are moving across the sky in the opposite direction. The clouds become stationary, for in the vast expanse of sky there is little with which to compare them. They become one's stationary anchor for space at the moment. The moon changes its position with reference to the clouds, and so it has to move. A similar thing happens when sitting in a train standing at a station when the train next to yours actually starts to move. It has been a very large part of your stationary world up until then, and remains so. You get the forcible impression that your own train is in motion. Only when you fail to receive the customary jarring and jostling given through kinesthesis do you sometimes realize the truth.

(3) *Illusions of Speed.* Several kinds of illusions of speed have been observed. Observers of moving motor cars, either as passengers or as onlookers, usually underestimate low speeds and overestimate high speeds. There is a rapid adaptation to speed, so that a fast-moving car or airplane may seem motionless to its

occupants, and the ground, when visible, becomes the moving object. We are oblivious to the swift gyrations of the rotating earth as it hurls itself through space. Only accelerations or decelerations of the body as a whole are sensed directly.

Apparent Movement from Successive Stimuli. A stimulus object, for example, a line (see Fig. 10.28), actually traversing a short section of the visual field from point A to point B, gives a visible motion. Suppose that we curtail the stimulation by showing the line first only at A, and then, after a short time interval, only at B. If the time interval is long enough the observer will see exactly what has happened. But reduce the time interval between the two stimuli to about 0.06 second, and he sees something different. He reports that only one line appeared and that it moved across from A to B.

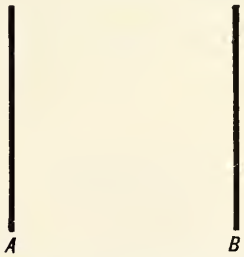

FIGURE 10.28. Apparent movement from stationary stimuli. If line *A* is exposed for a moment then after a fraction of a second line *B* follows, a single line may be seen moving from *A* to *B*.

The Motion Picture and Television. The interval, 0.06 second, means a rate of exposure of about 17 pictures per second. If we continued, showing 17 lines per second, each one just a little more advanced in position than the one before, we should have the impression of a continuously moving line. That is essentially what happens in motion pictures. The camera takes a rapid succession of still photographs, each one showing things slightly in advanced positions as compared with the one preceding. The projector shows them at the usual rate of 24 per second with dark intervals between them, and the effect is movement. More than 17 per second are shown in order to smooth out the jerkiness that would otherwise occur in rapidly moving objects.

Television also depends upon this principle of apparent movement for its transmission of pictures. Added to this, however, is the principle of scanning. By this is meant that the scene photographed with the television camera is actually exposed bit by bit in ultra-rapid succession by a scanning device. The eye and the brain have an unusually difficult organizing task in viewing the television screen.

Other Examples of Apparent Movement. The apparent-movement effect is a way the brain has of organizing excitations coming to it in a certain time-and-space order. This order is like that of real movement but with gaps in it. The phenomenon can be seen in its simplest form in the shifting traffic lights in any city, or in the moving electric-light signs. A very simple experiment not requiring lights is to hold a forefinger vertically six inches in front of your nose. Look beyond the finger. Close first one eye, then the other, alternately, and watch the finger move. The facts of this chapter should enable you to explain what happens.

Summary

Sensory excitations arrive in the brain over multitudes of nerve fibers. The brain must bring order into the welter of excitations impinging upon it. Excitations must be grouped and segregated in order to make the resulting perceptions correspond as nearly as possible with the world the organism is trying to know.

Simultaneous excitations, excitations following one another closely, similar excitations, in fact, excitations that form natural groupings for any reason, tend to fuse into larger units. Thus objects are formed in the visual field. Many combinations of excitations are capable of being organized in more than one way. We are aided somewhat by having had previous experiences and by having mental sets which favor correct groupings.

The figure-and-ground phenomenon is a characteristic way of closing an object off from things surrounding it. The important step in this is the formation of a boundary line. The protective

coloration of animals and the use of camouflage both depend upon the confusing of boundary lines.

When our organizations do not reflect accurately the "reality" of the situation stimulating us, we have illusions or errors of perception. Some types of illusions are so common they are regarded as normal. Illusions of shape and size obey a few recognized principles. They represent constant errors for which we can make allowances in architecture and other arts.

An individual's chief concern with space is the accurate location of objects with reference to himself. The individual himself represents the frame of reference within which things are arranged. The visual sense gives the most accurate impression of the location of external objects, though it also makes errors. The process of determining the distance of an object by sight depends upon many cues other than visual ones and other than those that help to place its direction. Two-eyed vision alone is responsible for our seeing objects as being solid and seeing our space as having the third dimension.

The perception of visual movement depends upon the stimulation of neighboring receptors in sequence. There are both lower and upper limits to speeds that can be seen as movement. Illusions of speed are numerous and sometimes are disastrous. Motion pictures and television views arise as illustions when still pictures (or in the case of television, minute portions of pictures) are shown in rapid succession with unnoticed blank intervals between.

Questions

1. Why is it incorrect, strictly speaking, to say that we see with our eyes?

2. What is your conclusion as to the kind of person who readily obtains reorganizations of a perceived pattern as compared with one who has difficulty seeing changes? Would you expect the person who sees many shifts per minute in an ambiguous figure to be likely also to see hidden objects in a puzzle picture more quickly? Give reasons for your answer.

3. Make some drawings of new examples of your own to illustrate the factors of contiguity, similarity, continuity, and inclusiveness.

4. Describe several types of military camouflage and tell what psychological principles apply.

5. Give samples of your own, illustrating figure and ground, in other senses as well as in vision.

6. What advice would you give to those who design and make automobile license plates? Defend your advice on the basis of psychological principles.

7. A vertical line 100 millimeters long is viewed at a distance of 280 millimeters from the nodal point of the eye (see Fig. 10.20). Assuming that the nodal point is 14 millimeters from the retina, how long is the retinal image (also assuming for practical purposes that the retina is a plane)? How long would the retinal image be if the same line is viewed at a distance of 140 *centimeters?*

8. A visual afterimage, when seen projected upon a background 200 centimeters from the nodal point of the eye, measures 10 centimeters in diameter. How large in diameter would the afterimage appear when projected at a distance of 40 centimeters? Explain.

9. Explain the reversed depth effect in Fig. 10.24, when it is viewed upside down. Hint: Consider the apparent direction of the source of illumination.

10. In view of the facts of this chapter, suggest a number of abilities that should be tested in the examination of individuals who apply for a driver's license.

11. Cite some examples of apparent movement (from successive stationary stimuli) that you have observed. How complete was the illusion? If it failed to give good movement, explain.

12. Should a one-eyed person be permitted to drive a motor vehicle in city traffic? Give reasons.

13. Report any instances you know about in everyday life in which geometric illusions played a role.

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CHAPTER XI

Hearing

No small part of our human environment consists of language stimuli. In fact, it is safe to say that verbal stimuli, spoken or written, have more to do with regulating our actions and with controlling our development than does any other one class of stimuli. We literally live in a verbal environment; the morning newspaper, the radio, the magazine, the talking cinema, television, the classroom instruction, the social gathering, all furnish that milieu of language from which we cannot escape unless we choose to be hermits.

No small percentage of this stimulation is in the form of spoken language. Eliminate the time we spend absorbed with newspaper, magazine, latest best seller, or school textbook, and the remainder of the waking hours are left to auditory verbal stimulation. In addition to the hearing of speech there is the almost daily ration of music and its enjoyment through the auditory sense. Add to this the perpetual stream of less musical sounds that give us a running account of what is going on around us, and you have a more complete list of items on the credit side of the ledger for hearing. While there are times when we regard distracting sounds as a curse to concentrated mental effort and there is much in the form of speech and music we could very well do without, no one would voluntarily give up his sense of hearing. He would prefer his world with sounds left in. In the next few pages we shall see

in general how all the variations in sounds are produced and how our mechanism for hearing operates to create what we hear.

Sound Waves

The correspondence between sound stimuli and the sounds that we hear is even more close than is the case between light waves and colors. There is scarcely a variation in the sound wave entering the ear that does not have its immediate counterpart in what we hear, and there are very few disturbing factors to interfere. Let us notice first what variations can occur in sound waves and then what corresponding variations are produced in the sound experience.

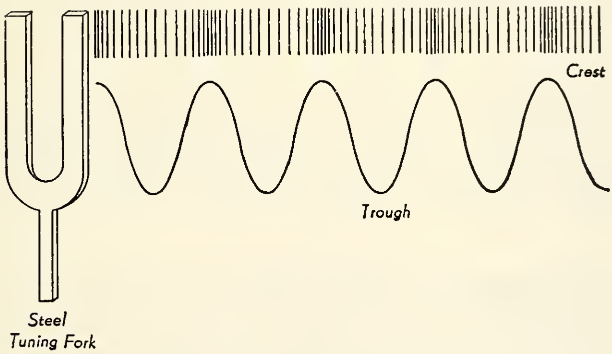

Figure 11.1. Diagram of a sound wave being produced by a tuning fork. The vertical lines at the top show successive condensations of air alternated with successive rarefactions traveling out from the vibrating fork. Actually they go out in all directions. Only a small segment is shown here. The "sine curve" below shows how a recorded wave looks when it is done with a writing point (not shown) that is activated by the air waves.

How Sound Waves Are Produced. Sound waves are ordinarily produced by the vibrations of an elastic body such as a steel bar, a taut string or wire, or almost any rigid object. Strike wood. glass, or stones with a solid object and sounds may be heard. A blow upon an object sets it into vibration. The effect of the vibration is carried to our ears by means of the air. Air is also an elastic substance. Being much thinner than the vibrating body it is easily displaced by those vibrations. Fig. 11.1 illustrates this. As the prong of the tuning fork swings to the right it compresses

the air before it, and as it swings to the left it suddenly pulls back on the air to the right of it creating a partial vacuum. By this time the first compression has traveled on to the right; then a second swing to the right starts a second compression traveling after the first, and so on. Traveling at the rate of about 1,150 feet per second (or about 780 miles per hour), at sea level, this succession of waves goes on and on.

How Sound Waves Differ from One Another. The simplest sound waves, like the ones shown in Fig. 11.2, are periodic, that is, the time between one peak and the next is always the same. But some vibrating bodies swing to and fro rapidly and some slowly.

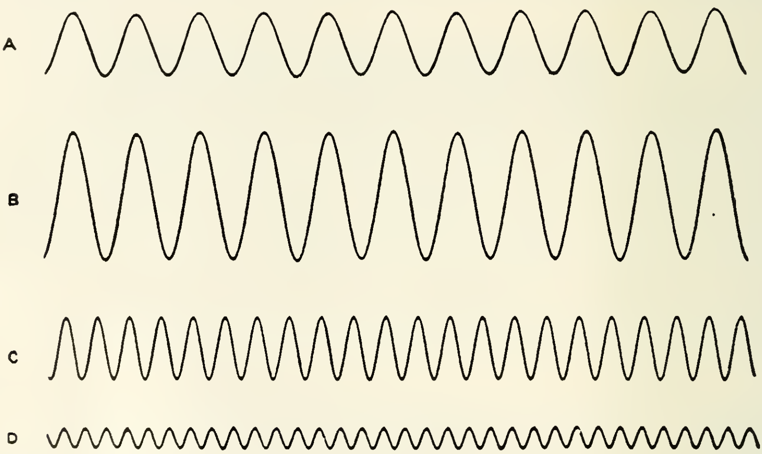

FIGURE 11.2. Sine curves representing sound waves varying in frequency and in amplitude. Waves A and B are of the same frequency but of different amplitude. Waves A and C are of the same amplitude but of different frequency.

Some may complete only 10 or 20 cycles per second while others may complete hundreds, even thousands. A cycle is a complete wave, including a swing to the right, then to the left, and back again. This would be represented in the record as the distance from one crest to the next, or from one trough to the next.

The Frequency of Sound Waves. The number of cycles per second is called the frequency of the sound waves. This may vary all the way from only a fraction of a swing per second up to a hundred thousand or more. Fig. 11.2 shows two registered waves,

A and C, that differ only in frequency. Supposing that the total length of times represented in this picture is one-tenth of a second, since there are 11 cycles in wave A and 22 in wave C, A has a frequency of 110 cps * and C has 220 cps.

The Energy of Sound Waves. Waves also differ in energy, some being vigorous and some weak. In terms of our wave picture, this variation is shown by the *amplitude* of the wave. Fig. 11.2 shows two waves, A and B, that have the same frequency, but B

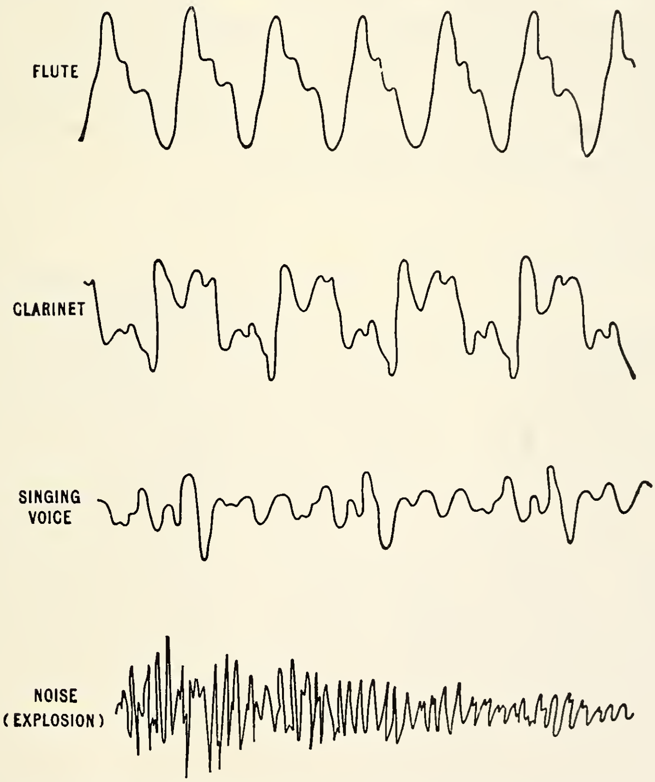

FIGURE 11.3. Sound waves varying in pattern or form because they are of differing compositions. (From D. C. Miller, *Science of Musical Sounds*, The Macmillan Company.)

has a greater amplitude. The difference in amplitude is shown by the width of the swings. Waves A and C have the same ampli-

* "Cycles per second" is often abbreviated as "cps."

tude but different frequencies. Wave D differs from all the others in both frequency and amplitude.

Wave Form. A third variation in sound waves is wave form. This comes from the "mixing" of two or more sound waves that differ in frequency or in amplitude or in both. Fig. 11.3 illustrates some simple and also some more complex patterns of waves. The first is that of a flute which has only two or three components; the second is that of a clarinet which has more components in it; the third is of the human voice, less musical than the flute and clarinet; and finally the sound wave of a noise, in this case an explosion. The number of components in a noise is usually very large; its wave form is very irregular and complex. This brings us to a correlation of the sounds we hear with the nature of the waves that produce them.

The Attributes of Sounds

It can be seen that, with the great variation in frequency sound waves may have and with the possibility of changing the amplitude at any frequency, the variety of simple sound waves alone is enormous. It is estimated that the normal person can distinguish as many as 340,000 pure tones alone.[1] When, in addition, we can combine any two or more simple waves into many possible wave forms, the variety of possible sounds becomes almost infinite. The "vocabulary" of sounds is infinitely richer than that of colors. The task of classifying sound experiences and of making sense of all the possible varieties is proportionately greater than it is in the case of colors. We have as yet no neat, systematic figure, like the color solid, with which to represent all sounds. It would probably take more than our limited three-dimensional space in order to construct such a figure. But we are fairly sure of certain attributes, that is, ways in which sounds may differ from one another. The best known properties of sound from the psychological point of view are: pitch, loudness, and timbre.

The Pitch of Sounds. Sounds vary in pitch from high to low; from the shrill chirping of the cricket or the squeaking of a mouse down to the booming voice of the basso or the zooming of a bass

viol. In the case of pure tones, the greater the frequency the higher the pitch, almost without exception.

Pure tones are not the only ones that have pitch. Almost no tones in nature are pure and yet most tones seem to be placeable on the scale of pitch. Certainly, musical and vocal sounds can be so placed. Even noises have a more or less definite pitch level. Hisses and squeaks and the like are of high pitch, the patter of rain and the gurgling of water have medium pitches, while the thud of blows and the rumble of thunder are of low pitch.

The Audible Frequencies. The ear does not respond to all frequencies. The lower limit for the normal human ear is usually given as 20 cps and the upper limit as about 20,000 cps. There are great individual differences in the upper limit. Some favored persons can hear tones of 30,000 and even 40,000 cps. Others cannot hear tones as high as the 20,000 cycle level. All individuals lose sensitivity to high frequencies as they grow older, some more rapidly than others. At the age of fifty, the upper limit is likely to be about 10,000 cps.

It is not strange that we have not developed sensitivity to a larger rate of frequencies, for the voices, music, and most of the noises around us fall within the limits from 60 to 10,000 cycles per second.[2] Lower animals show ranges of hearing similar to ours, but dogs and cats hear tones ranging up to about 35,000 and 45,000, respectively.[3] This is why dogs can respond to a whistle that we cannot hear. Bats have been found to emit sounds with frequencies even higher than this and to respond to echoes. That is the way in which they avoid obstacles. Thus, the bat developed what is probably nature's first type of radar system! Ships now detect the presence of submarines by using the same principle.

Discrimination of Pitch. Individuals differ markedly in their power to distinguish differences in pitch. The smallest difference that a person can detect is measured by changing the frequency of a tone by very small steps until he notices a difference. The observation is repeated a number of times, and the average change at which he reports a difference is called his *just noticeable difference* (*j.n.d.*) for pitch. The individual differences are so great

that one person may notice a change of one-half vibration per second while another requires a change of 20 to 30 or even more. These are, however, very extreme cases.

It is an interesting fact that we have many names for particular colors, but we do not have any names for particular pitches of sound. There are only an exceptionally few people who, when they hear a certain pitch, can give you a name for it. Then they probably name it in terms of the musical scale. They are better able to name it with reference to some particular musical instrument with which they are familiar. This ability is known as *absolute ear* or a sense of *absolute pitch*. There is much evidence that this ability can be developed to some extent by training. Most people have not been required to use such absolute impressions. In them the ability has remained latent.[4]

The Musical Scale. Although the hearing mechanism can respond to about ten octaves of frequencies, our musical scale in Western civilization is limited to seven octaves. Although a good ear can discriminate some 1500 different pitches or more,[5] music makes use of only about 88. Within much of the range of the musical scale a normal person can detect differences of less than one per cent, the steps between neighboring tones of the musical scale, known as *semitones,* are changes of 6 per cent. That is to say, each tone has a frequency 6 per cent higher than the one just below it. So far as easy discrimination is concerned we could just as well use a musical scale of quarter tones. Reasons for not deserting the present semitone scale are that more tones per octave would make fingering more difficult and that the wealth of musical composition made possible with steps of a semitone is sufficient to keep us interested, at least for the present. The musical scales of Oriental peoples and of the ancient Greeks differ from our own.

Loudness. The loudness of a sound depends primarily upon the amplitude of the sound wave; *the greater the amplitude the louder the sound.* It also depends upon frequency; *the higher the frequency the louder the sound.* This is because the quantity of energy delivered at the ear by a sound wave is increased by the higher frequencies. A higher frequency means more condensa-

tions of air hammering at the ear per second than for a low frequency, when amplitudes are equal. But even this is not the whole story, for the ear itself is built to be more responsive to medium frequencies than to very high or very low ones. So, while the relation of loudness to amplitude is a direct and simple one, the relationship of loudness to frequency is not.

Auditory Acuity at Different Frequencies. The acuity of the ear is measured by the weakest average stimulus to which it will respond. For every frequency this *threshold stimulus* can be determined by tests. The lower the threshold the greater the sensitivity or acuity. There is also an upper limit. Before we reach

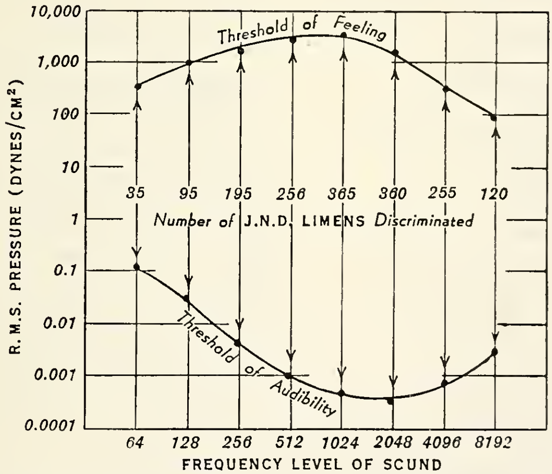

FIGURE 11.4. Lower auditory thresholds, upper thresholds, and numbers of steps discriminated at different frequency levels of sound waves. The vertical scale is one of energy of the sound wave. (From H. Fletcher's *Speech and Hearing*, D. Van Nostrand Company, Inc.)

the upper limit, that is, a stimulus too energetic to produce a sound, sensations of touch, kinesthesis (see p. 306), and pain begin to come in because the sound stimulus has become strong enough to excite other receptors than those for sound, in the region of the ear. With stronger stimuli than this there is danger of real injury to the ear.

We may take the point at which the stimulus begins to arouse sensations other than sound as the arbitrary upper limit for

hearing. Fig. 11.4 shows the range of audible intensities for different frequencies of stimulus covering a range of seven octaves. You will notice that the widest margins of good hearing come near the middle of the range of frequencies, at frequencies 512 to 2,048. Within this region, near 1500 cycles, to be more exact, the range of audible stimuli is so great that the strongest stimulus may deliver to the ear an energy one trillion times as great as the weakest.

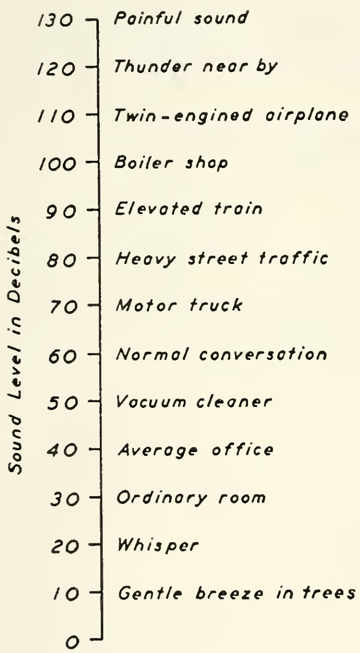

FIGURE 11.5. Comparison of some common everyday sounds as to characteristic loudness levels on the decibel scale.

The Decibel Scale. It is customary, particularly in sound engineering, to express the intensity of a stimulus in terms of *decibels.* A decibel is one tenth of a *bel,* which was named in honor of Alexander Graham Bell. The scale is a peculiar one in that increments are actually ratios. Thus, an increase of one bel (or 10 decibels) means making the stimulus energy ten times as great. A stimulus of 12 bels (or 120 decibels) is one trillion times as great as a threshold stimulus. A threshold stimulus has been arbitrarily chosen as one that delivers a pressure of 0.0002 dyne per square centimeter. The reason for this type of scale is that the loudness of a sound increases roughly in proportion to the logarithm of the energy of the stimulus. Fig. 11.5 gives some idea of the level of some common sounds on the decibel scale.

Timbre. Timbre is a property that comes from the composition of the sound wave or from the total wave form. A tone of the same pitch and loudness produced by piano, French horn, cello, and the human voice would still have different qualities. If one

is familiar with all these instruments he can tell from which instrument it comes.

Overtones. Most objects that give forth musical sounds, a wire, a string, a reed, or a bar of wood, emit more than one frequency of sound waves. A stretched wire, for example, vibrates not only as a whole its entire length swinging as one piece, but it also vibrates in parts: halves, thirds, fourths, fifths, etc. Each half vibrates at a frequency two times that of the whole wire, giving a sound whose pitch is one octave higher than that coming from the wire as a whole. We call the tone produced by the vibration of the wire as a whole the *fundamental* tone. The tone coming from the vibration of halves is the first *overtone.* The tone coming from vibrations of thirds of the wire, whose frequency is three times that of the fundamental, is the second overtone, and so on.

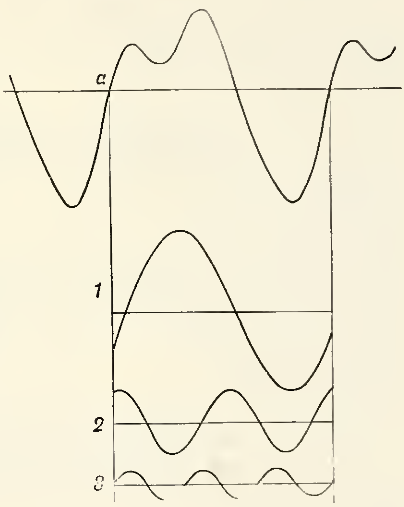

FIGURE 11.6. Diagram showing how a complex wave may be analyzed into simple wave components. The upper wave is that for a violin tone. It is the summation of the three components shown below it. (From D. C. Miller, *Science of Musical Sounds,* The Macmillan Company.)

The overtones harmonize very well with the fundamental and with one another, for the most part, and fuse into a unitary tone. The number of overtones that may occur varies a great deal. Fig. 11.6 shows how a relatively simple violin tone with the wave form shown at the top of the diagram can be analyzed into the components given below it. The total pattern is simply a summation of the wave motions of its components.

Musical Instruments. If all sounding bodies gave off the same number of overtones and all of the same relative strength there would still be no differences in timbre. But rarely do any two instruments give off the same number of overtones or the same

ones to the same degree. Reed instruments—for example, the clarinet, oboe, and saxophone—tend to emphasize certain overtones giving a common "nasal" sound. The trumpet, bugle, and cornet gain a brilliant, hard tone by emphasizing the high-pitched overtones. The selection of overtones in any instrument is partly due to the nature of the vibrating body and partly due to the kind of resonating parts of the instrument, for example, the bell of a horn or the chamber of a violin.

Human Voice Sounds. In a similar way each human voice gains a certain timbre. One singing voice is tenor, another contralto, and still another coloratura. Each individual's speaking voice has a characteristic timbre by which his friends recognize it even over the telephone. The cavities of one's mouth and nasal passages, one's facial bones and chest walls are shaped differently from those in other individuals. Those parts serve somewhat the same capacity for the voice as do the chambers and sounding boards of musical instruments. They emphasize some frequencies and weaken others. To some extent we have control over some of these factors. For example, the mouth cavity is shaped by movements of tongue and lower jaw.

Vowel sounds have their own characteristic patterns of overtones with their peculiar wave forms. The fundamental tone of a vowel is determined by the vocal cords which also furnish a wealth of overtones. There may be some selection of overtones exercised by the chords themselves. The shaping of the mouth cavity does the rest. You say the vowel sound "ah" by pressing the tongue down and the vowel "e" by pressing the tongue against the roof of your mouth. Try to say these two vowels by reversing your tongue action and see what happens. Some wave forms registered during certain vowel sounds are shown in Fig. 11.7

Speech also includes the consonant sounds which are mouth sounds rather than vocal-chord sounds. They are more noisy than musical. The hissing sounds are composed of very high-frequency tones made by the whistling of air through narrow passages between tongue, teeth, and lips. The explosive sounds, for t, p, b, and d, are primarily lip noises. Whispering is talking without the use of the vocal chords.

Some Phenomena of Sounds

There remain a few sound phenomena to be mentioned that are of some importance. These are the phenomena of *beats* and *masking*. They arise from the combined action of two or more frequencies.

Beats. When two simple sound waves of the same frequency reach the ear, the two blend so perfectly that both are lost in the unison. The pitch remains unchanged but the loudness of the total is increased if the two waves are in *phase*, that is, in step

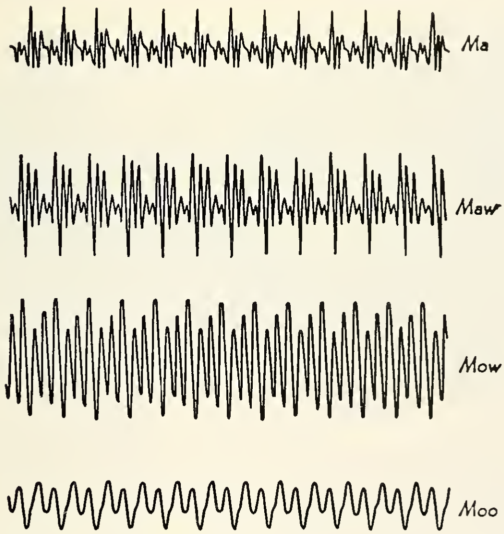

Figure 11.7. Diagram of sound waves for different vowel sounds. (From D. C. Miller, *Science of Musical Sounds*, The Macmillan Company.)

with each other. If the two are completely out of step, that is, in opposite phase so that the crest of the one coincides with the trough of the other, silence may be the result.

Now suppose that one frequency is slightly changed, for example, one frequency is 512 and the other 513. Once a second the two will be vibrating in phase, producing a louder sound; and once a second they will be out of phase, producing a weaker sound. The fluctuations in loudness thus produced are called *beats*. The number of beats per second will be equal to the difference

in frequency between the two tones. Tones of 512 and 522 cycles would produce ten beats per second.

Beats can be used in tuning musical instruments, for they enable one to detect differences in frequency very much smaller than one could observe directly in terms of a difference in pitch. An aircraft pilot also can make use of beats in keeping two motors running at the same speed.

Masking. It is no news to the average person that to make his voice heard in noisy surroundings he must raise its intensity

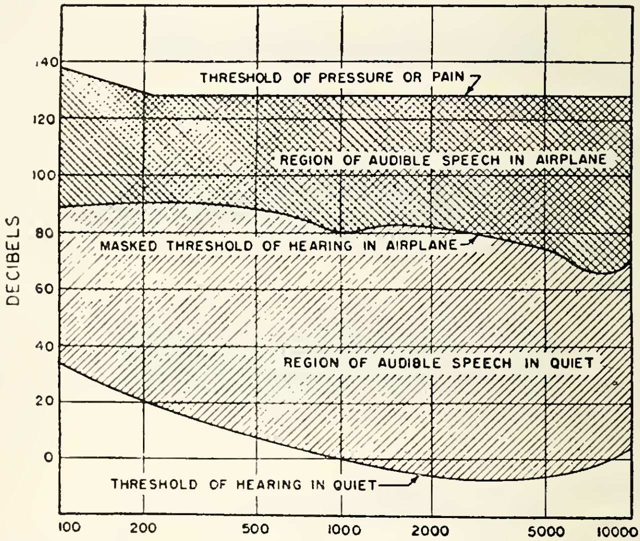

FIGURE 11.8. The phenomenon of sound masking. (Adapted from E. G. Boring, *Psychology for the Fighting Man*, courtesy of the National Research Council and the Combat Forces Press.)

to be heard above the din. When two or more sound waves are competing for the use of the same auditory mechanism, the stronger one wins out. This is the phenomenon of masking; a stronger sound obscuring a similar, weak one. Tones of nearly the same frequency as well as sound waves having too many frequencies in common will compete for the receptors of hearing, for there are undoubtedly different receptors for different frequencies.

Low-pitched sounds have more masking effect on high-pitched

ones than high-pitched ones have on low-pitched ones. Noises have more masking effect than do tones. Masking is especially bothersome in its effects on speech. The intelligibility of speech depends mostly upon the tones of high frequency. This has been shown by eliminating in turn both the high and the low frequencies by means of filters. With all frequencies below 500 cps eliminated, the loss in understanding speech is only about 2 per cent. with all frequencies above 1500 cps eliminated, the loss is about 35 per cent.

The masking problem has been especially serious where hearing signals or speech of others, is important, as in the cockpit of an

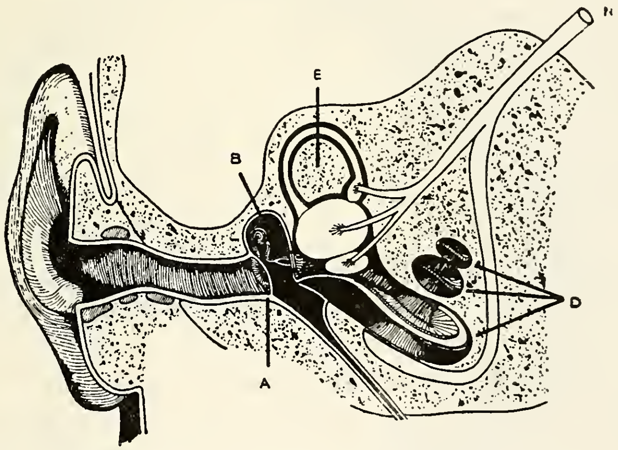

FIGURE 11.9. The human ear. (A) ear drum, (B) middle ear, (D) cochlea, (E) bone of the skull, and (N) auditory nerve. (From T. Hough, W. T. Sedgwick, and J. A. Waddell, *The Human Mechanism,* Ginn and Company.)

airplane, a military tank, or in the din of battle noises. The misunderstanding of a signal under such circumstances might lose an important battle. Much effort has been given to discovering the facts about masking in such situations and to finding better ways of signaling on a background of noise (see Fig. 11.8).

In general, however, in view of the almost infinite variety of frequencies affecting the ear at the same moment, it is really amazing how well we can keep certain components grouped together unmasked, so that the buzzing sound of a bee can be kept isolated from the humming sound of a motor, and both from the

conversation of a friend. The auditory mechanism is a remarkable analyzing instrument although it is not perfect, as we have seen in the phenomena of beats, fusion, and masking.

The Mechanism of Hearing

Any account of hearing is incomplete without some comments about the bodily structures that make it possible. The anatomy of the ear is well known in detail but our knowledge of how it works, that is, its physiology, is not yet quite complete.

The External and Middle Ear. Fig. 11.9 shows the arrangement of the external, middle, and inner ear. Sound waves enter the auditory canal of the outer ear and set into vibration the eardrum stretched across the canal at the entrance of the middle ear. The middle ear carries the vibrations on to the inner ear by means of the *hammer, anvil,* and *stirrup* bones, which act as a system of levers. The base of the stirrup bone is attached to the *oval window,* the entrance to the inner ear where the vibrations must be transferred to the liquid that fills the inner ear.

The Inner Ear. The inner ear has three main parts, the *vestibule,* the *semicircular canals,* and the *cochlea.* All have an outer shell of thin bone filled with liquid. The vestibule and the canals serve as sense organs for another sense, that of bodily movement, although the liquid of the vestibule does transmit sound vibrations onward to the cochlea. The latter contains the receptor cells for hearing. It is really a tube that is wound up snail-like. Fig. 11.10 shows a cross section of the cochlea. It will be noticed that across the middle runs a shelf or partition. This extends almost to the upper end of the tube. Lying on the shelf is the *organ of Corti.*

The Organ of Corti. This is the real organ of hearing. Beneath the organ of Corti, and as a part of the shelf that runs across the tube of the cochlea, is the *basilar membrane.* This is composed of a very large number of transverse fibers, varying (1) in length, (2) in the amount of tension under which they are suspended, and (3) in the amount of loading attached to them. The basilar membrane with its fibers suggests immediately a stringed instru-

ment like the piano or harp. This has been the key to the understanding of how the organ works.

How the Receptors Are Stimulated. It is believed, on the basis of very good evidence, that each part of the basilar membrane responds most completely to some one frequency. We cannot say that each fiber in it vibrates alone, for the fibers are bound together and it is known that a single frequency may agitate many fibers. While it does so, there is undoubtedly a focal point at which the

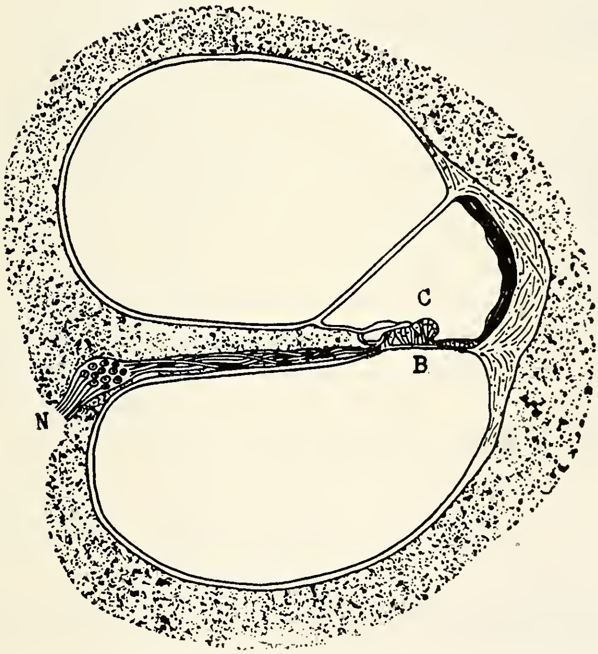

FIGURE 11.10. Cross section of the cochlea. (B) basilar membrane, (C) organ of Corti, and (N) auditory nerve. (From D. J. Cunningham, *Anatomy*, Oxford University Press.)

response is at a maximum, or about which the response centers. The more intense the stimulus, the more of the entire basilar membrane is brought into play. Once the basilar membrane is in vibration, or a limited part of it, certain *hair cells* in the organ of Corti that rest upon it are also agitated. In touch with these cells are the receptor cells.[6]

Some Defects of Hearing. The most serious defect of hearing is, of course, complete deafness. But there are many other, milder deficiencies in acuity of hearing. The number of "hard-of-hearing" individuals is much larger than most people suspect. Tests of 2,078 typical school children revealed that 13.3 per cent had defects worthy of attention, and only half of these knew that their hearing was defective.[7]

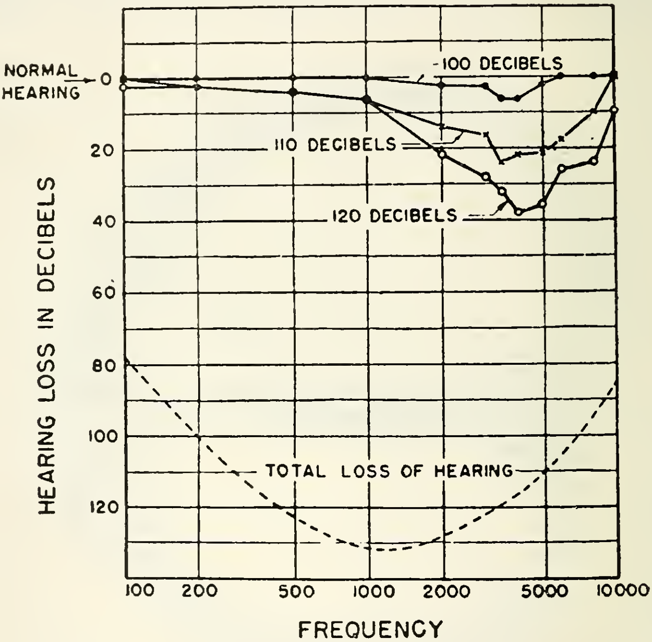

FIGURE 11.11. Degrees of stimulation deafness produced by long exposure to a loud sound. (Adapted from E. G. Boring, *Psychology for the Fighting Man,* courtesy of the National Research Council and the Combat Forces Press.)

One curious reaction of a hard-of-hearing person is that of shame, as if he were guilty of a moral lapse. Rarely does an individual hesitate to wear spectacles for defective eyes, but it is a rare individual indeed who will wear as obvious aids to hearing or who will seek help even when he realizes his defect.

Stimulation Deafness. Using laboratory animals, either rats or guinea pigs, to investigate how the inner ear operates, the experimenter may intentionally overstimulate the ear with a very strong

tone of a certain frequency, keeping this up for hours, even for days. The typical result is that the ear becomes relatively deaf to the particular frequency used and it suffers also much loss for hearing tones near that frequency or even tones of more remote frequencies. Recovery from such overstimulation is very slow and probably never complete. Intermittent tones cause more damage than continuous tones.[8] Human beings who work in noisy factories undoubtedly lose hearing acuity, some to the point of deafness, from overstimulation.

The Hearing of the Blind. There is a common belief that because a person is blind Nature compensates him by improving the acuity of his hearing and other senses. Careful studies of the blind prove that this is decidedly not true. The blind can neither hear fainter sounds nor make finer discriminations between sounds in pitch or in loudness than those who can see. The truth of the matter is that a blind person makes more complete use of what he does hear. He gives close attention to echoes and minor stimuli that to us mean nothing. This is not a God-given gift; he works for it. A blind individual at a school for the blind for the first time may be found to stop, clap his hands, and listen for echoes, then proceed on his way. Put soft-soled shoes on the blind in place of the customary ones that produce audible footsteps and echoes, and they are bewildered and lose their way about. Snow on the ground is for the blind man what a fog is to the man who sees. The general conclusion should be that the normal man with all his senses is equipped with far more resources than he ever uses, and that when forced by circumstances to use them it is surprising what he can do with them. Nature's margin of safety is usually very wide.

Hearing as a Space Sense

Localization of Sounds. The problem of localizing sounds has two phases—direction and distance.

The distance of the source of the sound is judged primarily by its relative intensity when we know the type of sound; a loud train whistle is near and a weak one is far away. There are other differences between near and distant sounds of which we are

usually unaware, but which are sufficient at times to give cues as to the distance. Distant sounds have less volume, and some, especially noises, have a different timbre.

In order to place a sound in its correct direction, right or left, we need the cooperation of the two ears. Sound waves coming from either the right or the left have different effects on the two ears. There are four factors, three of them depending upon the two ears:

(1) *Difference in intensity in the two ears.* Although one ear is only slightly nearer the source than the other, the difference is often great enough to be useful. If louder for the right ear, the sound is localized to the right of the median plane that divides the body into two halves, right and left.

(2) *Difference in phase in the two ears.* Remember that the sound wave consists of a succession of crests and troughs (see p. 273). As they travel along past the head, the crest of a wave strikes one ear slightly in advance of the other one. The brain is affected by this and places the sound to one side.

The intensity difference is a better cue for tones of high frequency. The phase-difference cue is better at low frequencies. Tones of moderate frequency are not so well localized, especially if the wave length is about the same as the distance between the two ears so that both ears receive the same phase of the waves simultaneously. We can take better advantage of these cues, and the next, by turning our heads slightly. This would throw the sound source to one side of the median plane. When the source is on the median plane, we cannot tell whether it is front or back or above the head.

(3) *For complex sounds there are slight differences in timbre in the two ears.* Complex tones and noises are thus more easily localized than pure tones.

(4) *Mental set.* When the source of the sound is visible, and if we expect the sound to come from that source it will do so. By means of an instrument known as the pseudophone (see Fig. 11.12), sound waves intended for the right ear are sent over the head into the left ear and vice versa. The factors of difference in

phase and intensity may force the brain to place the sound to the right when its source is really at the left. With the eyes open the sound may still seem to come from the right after some training with the pseudophone. Imagine seeing a face talking silently at your left and hearing a voice from nothing at your right! When there is a mental set to hear the sound in the direction of its source, however, the factor of set overcomes the others, and the sound issues from its true source.[2]

This is one secret of the talking picture. The loud speaker is located above the center of the picture screen. Yet you hear voices

FIGURE 11.12. Young's pseudophone. Sound waves entering the bell-shaped receiver on the individual's right are conducted over the head through the tube to the left ear and sound waves entering the receiver on the left are carried similarly to the right ear.

issuing from the mouths of actors in different parts of the screen, and it is difficult to get away from this habit even if one tries. The success of ventriloquism is due to the same factor. The ventriloquist has trained himself to talk with his lips motionless. He does not "throw his voice." You throw it. He helps your mental set by looking expectantly and intently at his dummy while the latter is speaking. He moves its lips and body to strengthen your belief that the voice comes from that direction.

Summary

Sound waves originate with some vibrating object and are usually transmitted by the air to our ears. The waves vary according to the number of vibrations per second, they also vary in am-

plitude or vigor, and they vary in composition. Composition depends upon the various frequencies (number of vibrations per second) included in the waves.

Corresponding to these variations in the stimulus are three important properties of sound, namely, pitch, loudness, and timbre, correlated with frequency, amplitude, and composition (or wave form), respectively.

Human abilities to discriminate pitches of tones, and also different degrees of loudness, have been accurately measured. Discriminations and acuity near the middle of the scale of frequencies are much finer than near the ends of the scale. Individual differences are very marked.

Timbre is the important attribute of sound that accounts for differences among musical instruments, among human voices, and among vowel sounds.

The ear is an elaborate mechanism for transforming the mechanical vibrations of the air into vibrations of liquid that surrounds the receptor cells connecting with the auditory nerve. Certain receptor cells respond most fully to each frequency of sound wave. The receiving organs can be damaged from prolonged overstimulation. The acuity of hearing, as such, in blind persons is no greater than in persons with normal vision.

The distance of a source of sound from us is judged from the loudness and timbre of sound of that type. The direction of a sound is determined by differences in loudness, phase of the sound wave, and timbre of the sound for the two ears and by our mental set.

Questions

1. The variety of sounds we can hear is infinitely greater than the variety of colors we can see, and yet seeing is generally more useful than hearing. Explain.

2. Explain the importance of pitch discrimination, loudness discrimination, and appreciation of consonance, for the pianist, violinist, vocalist, and composer.

3. Explain how it is that there can be hundreds of millions of people, each with a speaking voice that can be distinguished from all others.

4. Cite evidence to show that unused sensory equipment does not necessarily deteriorate with disuse.

5. How can a person who has lost his eardrum and the bones of his middle ear still be made to hear? Why?

6. How is it that the pipe organ can be made to imitate other musical instruments and even the human voice?

7. What military devices that you know of have been based upon the principles for the localization of sounds?

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CHAPTER XII

The Simpler Senses

The "simpler" senses include all except seeing and hearing. They are simpler only because elaborate accessory apparatus such as we find in the eye and the ear is lacking, or because they give us only simple patterns of experience that yield only crude information of things outside or inside us. We are usually attentive to visual or auditory stimulation and are most observing to things seen and heard. The effects of stimulation of the other senses are, therefore, rarely conscious, and when conscious they are often relegated to the background. This does not mean that the simpler senses are of little value. Without them the vital processes of the body could not be carried on successfully. They merely contribute their measure of control of the entire nervous system in more direct and automatic ways than do the senses of sight and hearing.

Taste

The senses of taste and smell are very intimately related in their use and in their operations. It is thought that both have evolved from a single primitive sense, found in fish and other lower forms of animal life, known as the *chemical sense*. The stimuli that excite them are chemicals, and in the primitive form there was only one set of receptors. The two senses still cooperate in the selection of food and in the rejection of noxious substances that might otherwise enter the stomach as foods.

The Taste Receptors. The receptor cells responsive for the sense of taste are located not only in the tongue but also in the linings of the cheeks and throat. A single cluster is called a *taste bud* (see Fig. 12.1). Children have more taste buds, particularly outside the tongue, than adults. A tiny opening in the surface of the tongue or other tissues of the mouth admits saliva into the taste bud, and in order to stimulate the taste cells a chemical must be in solution.

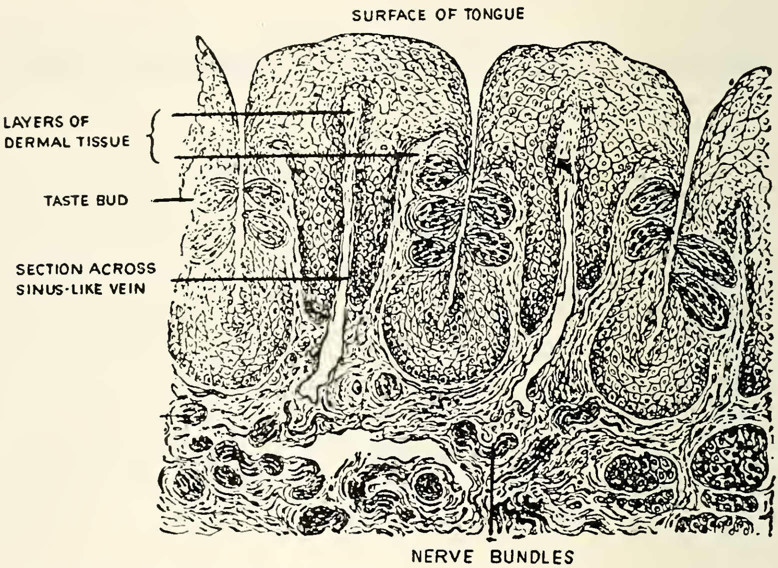

FIGURE 12.1. Cross section of papillae of the tongue of a rabbit. (From F. H. Lund, *Psychology,* The Ronald Press Company.)

The Taste Qualities. The variety of taste experiences, contrary to common belief, is extremely limited. The "taste" of hot coffee, for example, is limited to a bitter taste, and if sugar is added it also has a sweet quality. The remainder of the experience obtained from hot coffee consists of heat, which is a temperature sensation: the feeling of the liquid in the mouth, which is a touch sensation; and the aroma, which is an odor and not a taste sensation. Stuff the nostrils thoroughly so that no stimulus can reach the smell receptors, and you cannot tell the difference between the juice of turnips, carrots, potatoes, and even onions, when

placed on your tongue. The broths from chicken, beef, pork, and lamb would probably taste alike. It is the sense of smell that deserves most of the credit for the enjoyment of the creations of the culinary arts. Our attention is centered on the delicious food in the mouth. We refer the pleasing flavors given by the sense of smell directly to the food, and taste gets the credit.

All the varieties of taste can be included within a figure known as the *taste tetrahedron* (see Fig. 12.2). At the four corners are the primary qualities, *sweet, salt, sour,* and *bitter,* and between the corners are intermediate tastes that resemble two primaries (see Fig. 12.2). Since there are also qualities that resemble three

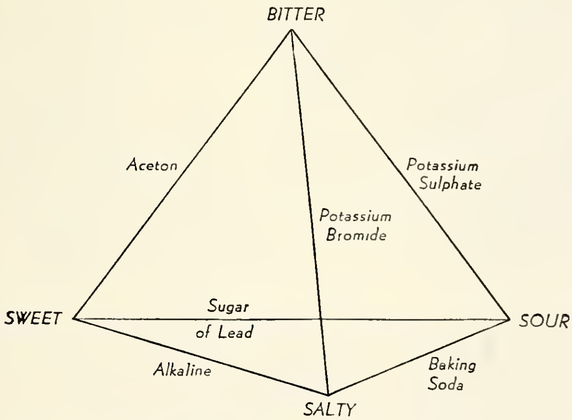

FIGURE 12.2. The taste tetrahedron. (From C. A. Ruckmick, *The Mental Life*, Longmans, Green, and Company.)

primaries and also some resembling all four, the figure is a solid one.

Some Phenomena of Taste. As with most senses, there is adaptation to taste stimuli, whether sweet, salt, or bitter. Leave any solution in the mouth long enough and all taste for that quality is lost.[1] Bitter grapefruit or coffee taste less strongly bitter as one continues eating or drinking them. Soup that tastes too salty at first soon is bearable and may later call for more salt to restore its desired flavor. As in vision, there are aftereffects to adaptation. After complete adaptation to salt, a stimulus that ordinarily arouses all four qualities will then give rise to the other

three, minus salt. Specific contrasts are often noted under these conditions. After eating candy an orange seems extremely sour; after a lemon the same orange seems sweet.

No part of the tongue is equally sensitive to all four primary tastes. Bitter is sensed most easily at the back; sweet at the tip; sour along the sides; and salt about equally well over the entire surface of the tongue. It is possible that there are four kinds of receptor cells, one for each primary quality. The physiology of this is not yet known.

Deficiencies of Taste. Corresponding to the color-blind individuals as regards vision, there are persons who lack taste sensitivity to some substances, although they may possess all four primaries otherwise. One substance known as phenyl-thio-carbamide is tasteless to about 25 per cent of the white population, whereas it tastes bitter to most people, sour to a small percentage, and even salty or sweet to a few.[2] The defect seems to be hereditary and slightly more prevalent among men than among women. A few other substances are known that are tasteless to some individuals and of doubtful quality for those who do taste them.

Smell

The sense of smell at least deserves the distinction of having been associated with the cerebrum from the very beginning of its development. It is still the only sense that sends nerve impulses directly into the cerebrum without going indirectly by way of lower centers. In lower animals it serves to guide all the functions of life; in higher forms it still serves the functions of respiration, nutrition, and reproduction. Though replaced to a large extent in man by sight, it is ready to serve in very subtle ways, as the blind can testify. The blind tell us that it is possible to identify people they know by their odors. Each person has his unique odor, probably due to his diet, perspiration, sebaceous secretion, skin pigment, and glandular balance. Odors and the sense of smell do play a role even in modern civilized life. The air we breathe and the food we eat must come under the inspection of the *olfactory* organs.

Is the Sense of Smell in Man Degenerating? It has been suggested that since most odoriferous vapors and gases that supply

the stimuli for smell are heavier than air and cling to the ground, and since man's erect posture keeps his nose away from the ground, his olfactory sense is deteriorating from disuse. Many species of birds that have lived off the ground for many generations have but a rudimentary sense of smell or none at all. It may be thought that the same fate is in store for man, but this is probably not the case. The sensitivity to odors is extremely great. Some human individuals have been shown to have an acuity approaching that of hounds, though human differences are very great in this respect.

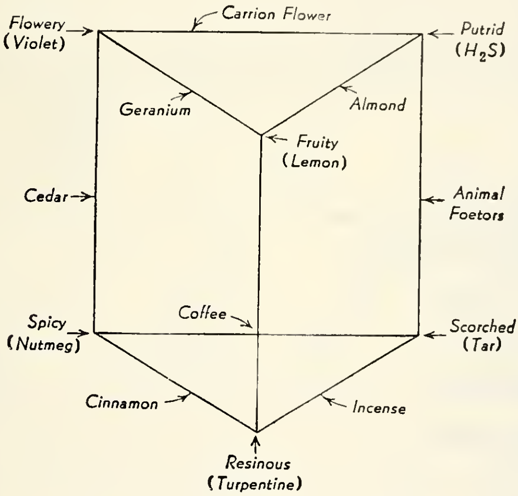

FIGURE 12.3. Henning's smell prism.

An idea of the very weak stimuli to which we respond may be gained from the fact that mercaptan can just be smelled when it is mixed one part mercaptan to 50,000,000,000 parts of air, and it creates a vile stench when mixed only one part in 300,000,000 parts of air.[3] Abnormalities of this sense are extremely rare. The variety of odor qualities that the average person can sense is very large; perhaps as many as 60,000 distinguishable odors. Such facts do not suggest serious deterioration of the olfactory sense.

The Odor Qualities. All known odors can be classified in the *smell prism* proposed by Henning. The six primary qualities at the corners of the figure are: *flowery, fruity, spicy, resinous, putrid,* and *scorched* (see Fig. 12.3). Typical substances emitting these

six odors are listed along with the odors in Fig. 12.3. They are: violet, lemon, hydrogen sulphide, tar, turpentine, and nutmeg. Substances emitting odors lying intermediate to pairs of the primary odors are also given in Fig. 12.3.

There are some odors resmbling three primaries at the ends of the prism, and some resembling four on the sides of the prism. The odor of arbor vitae is flowery-fruity-spicy-resinous. The odor of onion is putrid-flowery-scorched-spicy. But there are probably none resembling more than four at a time, and the figure is therefore a hollow one.

The Organs of Smell. The receptors of smell consist of two small brown patches of tissue high up in the two nostrils about on the level with the eyes. A stimulus, to affect the receptors, must be in the form of gas or vapor and must be carried up to the receptors by means of air currents. Ordinary breathing wafts stimuli to them only very slowly. Sniffing speeds up the process. Swallowing forces a current of air upward from the rear, carrying with it the odorous particles from food in the mouth (see Fig. 12.4).

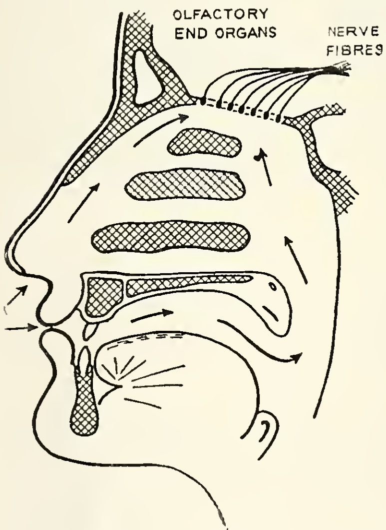

Figure 12.4. The smell organs. (From S. W. Fernberger, *Elementary General Psychology*, The Williams and Wilkins Company.)

The Tactual Sense

The sense of touch has its receptors in the skin and in the linings of the mouth, nasal passages, and to some extent in the esophagus. Fig. 12.5 shows a magnified section of the skin with its variety of receptors, some of which serve the senses of temperature and pain as well as the tactual sense. The usual stimulus is mechanical distortion of the skin either by pushing or pulling.

Sensitivity of the Skin. It has long been known that the skin is not uniformly sensitive. Within the same square centimeter of skin a pointed stimulus of a certain intensity, let us say one-half gram of pressure, will arouse a sensory response at some points and not at others. This is partly due to the fact that the receptors are scattered, but probably more important is the fact that the receptors themselves differ in sensitivity. The stronger the stimulus the more responses are obtained per square centimeter. The most sensitive parts of the body are finger tips, lips, and scalp. In general, sensitivity increases toward the extremities of the limbs. Sensitivity to small differences follows the same rule.

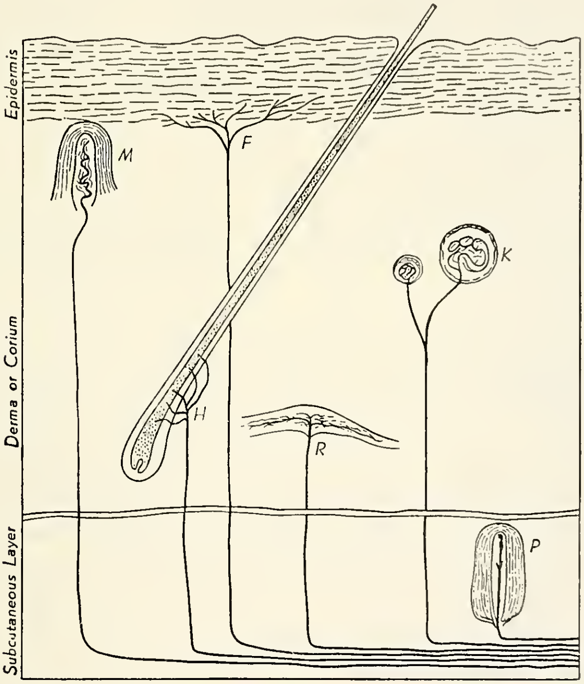

FIGURE 12.5. Diagram of the receptors in the skin. (M) Meissner's corpuscle, (F) free nerve ending, (H) hair bulb, (R) Ruffini cylinder, (K) Krause's end bulb, and (P) Pacini's corpuscle. (From F. L. Lund, *Psychology*. The Ronald Press Company.)

Adaptation to Tactual Stimuli. Adaptation to a stimulus, especially to weak stimuli, takes place very rapidly. Thus one loses

awareness of the pressure of one's clothing, including even a tight hat, and of spectacles, and rings. As compared with the other senses, when stimuli of comparable intensity are used, adaptation to tactual stimuli is most rapid.

The range of adjustment is very great. For example, people who shield themselves from every bodily discomfort become hypersensitive to all stimuli. At the other extreme, fakirs who walk through live coals with seeming lack of feeling probably undergo a process of more permanent adaptation or "hardening" to the extreme stimuli. The aftereffect of temporary adaptation is a positive afterimage. One feels the "presence" of a ring after it has been removed.

The Tactual Qualities. The typical qualities of sensation derived from this sense are *tickle,* as the hairs on the skin are touched very lightly; *contact,* as a more substantial stimulus is applied; and *neutral pressure* when even stronger stimuli are given.

Response to Vibratory Stimuli. The skin receptors respond to the mechanical vibrations of a tuning fork that touches the hand lightly. A fuzzy, vibratory sensation is the result. Sound waves in air are far too weak to excite the skin receptors directly. But they may be transformed into mechanical vibrations of a button or diaphragm against which the finger tips are held. Such a device is the *teletactor,* invented by Gault for the use of the deaf who may be taught to "hear" through their finger tips. Deaf individuals are able with this device to perceive 30 per cent more spoken words than they can by means of lip reading alone, and they can perceive 100 per cent more of total sentences.[4]

Touch Sensitivity of the Blind. Tests show that the blind, contrary to popular opinion, do not have any miraculous increase in the acuity of the sense of touch. The blind are inferior to seeing individuals in sensing weights and pressures.[5] Constant reading of Braille actually dulls the finger tips for delicate feeling. In sensing the presence of objects at a distance such as telephone poles or trees as the blind walk along the street, they report a feeling of "shadows across the face," of being "grazed on the face," and the like. When covered with a mask to eliminate tactual stimuli to

the face they still feel the facial sensations. It has been suggested that these feelings arise from reflex action of the muscles in the skin of the face, muscles that tend to raise the hairs on the face. The reflexes are initiated through some sense other than tactual.[6]

The Temperature Sense

Temperature Stimuli. Physically, heat is merely activity of molecules. The more vigorous and energetic the movement the higher the temperature. Physical temperatures may range from absolute zero, or 273 degrees below zero on the centigrade scale, to enormously high values, thousands of degrees above zero. Physically, nothing is warm or cold. Warm and cold are sensory experiences and require nerves and a brain to produce them.

The thermal receptors in the skin respond to only a limited range of external temperatures. The total range of stimuli that can arouse sensations of cold or warm or heat lie between −10 degrees and +70 degrees C. Above and below those temperatures the only response is probably pain alone, and damage to the tissues takes place.

The Physiological Zero Point. Whether a thermal stimulus within the effective range for temperature sensations arouses warm or cold depends upon the temperature of the skin itself. At normal room temperatures of 20 degrees to 22 degrees C., the exposed skin of hands and face has a temperature of about 33 degrees, which is lower than blood temperature. There is a normal flow of physical heat from the blood to the air outside the body. When any stimulus tends to increase that flow by absorbing more heat from the skin, a cold sensation results. When any stimulus tends to reduce the speed of outward flow by giving up heat to the skin, warmth is felt. Stimuli above skin temperature arouse warmth; stimuli below skin temperature arouse cold. Exactly at skin temperature, neither warm nor cold is felt. Skin temperature is, therefore, called the *physiological zero* for thermal response.

Sensitivity to Thermal Stimuli. As in the case of the tactual sense, the skin is very unevenly sensitive to thermal stimuli. For mildly warm stimuli, especially, there may be large insensitive

areas. There are some spots on the skin that respond more readily with warm, and others that respond more readily with cold. These are called the warm and cold spots. But some very queer things happen here. Cold spots, that ordinarily respond only to temperatures below 33 degrees C., also respond to temperatures above 43 degrees C. When they do, they speak with only one voice, and that is "cold." This is called a *paradoxical cold,* for it is so unexpected and illogical. When the same stimulus, above 43 degrees C., also stimulates warm spots nearby, the combined response is neither warm nor cold, but that of *heat.* Thus, the sensation of heat is not an intense sensation of warmth. It is a fusion of warm and cold, in which most of the traces of warm and cold have been lost.

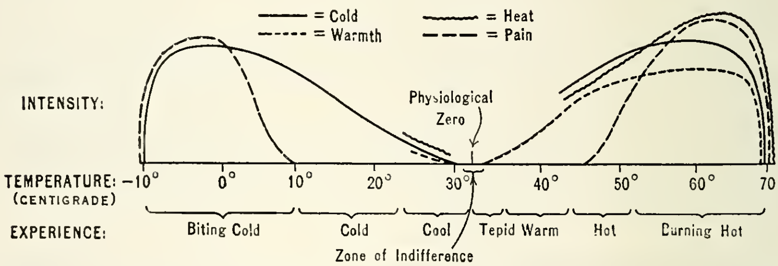

FIGURE 12.6. Correlation between the temperature of the stimulus and the thermal sensation. (After K. M. Dallenbach, in E. G. Boring, H. S. Langfeld, and H. P. Weld, *Psychology, A Factual Textbook,* John Wiley and Sons, Inc.)

There is also a *paradoxical warm* for temperatures in the region of 25 degrees to 30 degrees C., but it is so weak that when combined with the genuine cold from those same temperatures, it does not produce a sensation of heat.[7] Above 50 degrees C. and below 10 degrees C. the pain receptors are excited, and we get burning heat in the first case, and biting or stinging cold in the second. Fig. 12.6 shows in graphic form the scale of temperatures to which we respond, the ranges within which the two kinds of receptors respond, and within which the various qualities are normally aroused.

Adaptation to Thermal Stimuli. Raising or lowering the temperature of the skin, as most stimuli do, changes the physiological zero point upward or downward, as the case may be. The

sensation tends toward indifference as this process continues. There is complete adaptation to small pointed stimuli regardless of the intensity of the stimulus, but to larger-sized stimuli adaptation is complete only for mild deviations from skin temperature.[8] A curious illusion may be produced because of adaptation. Place one hand in cool water for a minute or two, and the other hand in warm water. Then place both in water at about normal skin temperature. The same water will feel warm to the one hand and cool to the other.

Pain

Sensitivity to Pain. Pain can be aroused in almost all parts of the body in connection with many kinds of tissue. The stimulus may be of any kind of energy that injures or threatens to injure tissue. The skin is richly supplied with pain receptors, although some regions are more sensitive than others. In general, the skin is more sensitive at the extremities, near joints, and at places, like the neck, where large nerves and blood vessels come near the surface. Sensitivity to pain in the teeth is said to vary at different times of day, rising steadily from 8 A.M. to a maximum at 6 P.M., and then dropping rapidly until midnight.[9]

Qualities of Pain. Not all pains are alike. Mild stimuli merely produce an *itch or prick,* which, as the stimulus grows stronger, may become a *clear pain.* These mild forms are not always unpleasant, and are certainly bearable. Certain regions very readily give rise to a more sharp, intense, and unbearable quality called *quick pain.* Such pains are easily aroused underneath the fingernail, in the ear, or in a deep cavity in a tooth.

Time Relations. While pains are universally danger signals to the organism, and they are urgent in their demands, curiously enough, the pain response is the slowest of all. A pin prick on the hand may first arouse a pressure sensation, and perhaps cold, before pain comes in. This is probably because the fibers carrying impulses to the brain for pain are very small in diameter. Other factors may also delay the pain sensation. When one is distracted from an injury all pain may be completely inhibited until attention is called to the injury. A strong pain in one locality may

obliterate a weaker pain in another. The secret is probably a matter of attention.

Adaptation to Pain. It is now known that there is adaptation to painful stimuli as well as to others, much as common sense may doubt this fact. The stimulus must remain constant, however, for any slight change in it brings back the pain. Complete adaptation may occur within ten minutes for an unchanging stimulus.[10] Most toothaches and similar pains are caused by internal conditions that are continually changing, and the fact of adaptation is therefore of little comfort to the usual sufferer. In this case, distraction and relaxation of one's muscles are probably the most effective devices.

The Kinesthetic Sense

The Proprioceptors. Scattered throughout the muscles, tendons, and joints are receptors that are stimulated by bodily movement. The contraction of a muscle, the stretching of a tendon, and the rubbing of bones one upon another at a joint furnish the necessary energy. These receptors come under the technical name of *proprioceptors.* They furnish the brain at all times during our waking hours with impulses indicating the position of our limbs and trunk and of changes of position or movement. Without them we would have a sorry state of affairs. Unless we could see our limbs at all times we would have little or no knowledge of their positions, and little control over our movements. Individuals whose kinesthetic tracts in the cord have been severed are, as a result, almost unable to stand or walk.

The Kinesthetic Qualities. Clench your fist vigorously and notice the feeling aroused in your forearm. It is best described as a *dull pressure,* verging on *dull pain* or *ache,* depending upon how strongly you contract your muscles and how fatigued you are. At other times, when you feel fresh and rested and in good health, your muscles fairly tingle with a quality best described as a *bright pressure.*

Clench your fist again and observe the feelings in your wrist and fingers where the tendons are being pulled. The sensations there are best described as *strains.* With extreme stimulation this

may go over into dull pain and ache. Relax your hand, grasp with your right hand the tip of the forefinger of your left hand and wiggle it back and forth at the joints. The typical sensation aroused in the joint is called *smooth pressure.*

The Static Sense

The Static Organs. These organs are located in the inner ear along with the cochlea. There are two distinct parts, the vestibule and the semicircular canals (see Fig. 12.7). Both are

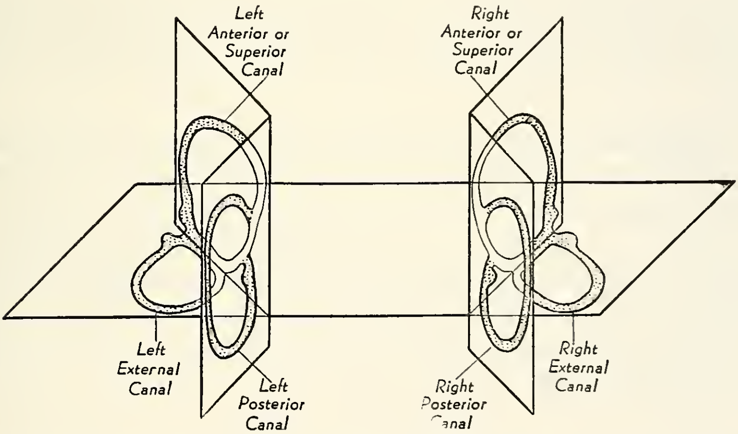

FIGURE 12.7. The semicircular canals. A diagram showing their positions in three planes of space. (From H. C. Warren and L. Carmichael, *Elements of Human Psychology,* Houghton Mifflin Company.)

filled with liquid and at certain places on the walls there are hair cells that are said to be stimulated by movements of the liquid. In either case, movement of the head in any direction, either in a straight line or in a rotation of any sort, is the cause of the stimulation.

Results of Stimulation. Stimulation of the static organs has widespread and varied results, mostly reflexive and unconscious. There is a turning of the eyes and an adjustment of the positions of head, limbs, and trunks as if in correction to a loss of equilibrium. Under normal conditions the result is better balance and more favorable bodily position, including the adjustment of the

eyes for seeing. Excessive stimulation leads to extensive visceral responses, a tightening of the abdominal muscles, reversed peristalsis in the esophagus, rapid flow of saliva, and perspiration.

The conscious results from all this include a swimming sensation in the head, dizziness or vertigo, and nausea. Little of this is aroused directly by the static organs themselves, except perhaps the dizziness and vertigo, and this is doubtful. Motion sickness, including air sickness and seasickness are attributed to a conflict between sensory stimulation from the static organs and from the eyes.[11] Both organs are stimulated by movement of the body in space. In ordinary locomotion the brain gets concordant information from the two senses. In locomotion on board ship and in similar unusual circumstances, the customary concordance is missing.

Adaptation. Fortunately, adaptation takes place for the static sense, and one recovers from unusual stimulation of the static organs. Dancers, acrobats, and stunt flyers find this usually true. Aftereffects are striking. One may feel his hotel room rising and falling a day or two following the end of an ocean voyage. After whirling around in one direction the impression is that one is turning in the opposite direction. The swimming sensation, likewise, reverses its direction.

Organic Sensations

Sensitivity of Internal Organs. While there is no single organic sense, the receptors that are scattered throughout the viscera and other internal organs yield sensory responses. Aches and pains are the most obvious of these, although other "queer" sensations are often reported. Many internal pains, such as cramps, come from the severe contractions of smooth muscles, or the distension of the alimentary canal with gases.[12] It is very difficult to study these responses experimentally, because the receptors are so inaccessible.

During abdominal operations it is found that the viscera are surprisingly insensitive to cutting, burning, or crushing. Even though local anesthetics were used merely upon the skin in these cases, it is doubtful that the viscera can be so insensitive in view

of the fact that they are so richly supplied with nerve fibers. The only conclusions possible are that the condition of the viscera during the operations is abnormal, or that the stimulation of them has mostly unconscious effects. The puncturing of arteries and veins and other deep tissues, gives rise to dull pains and aches. It also arouses widespread reflexive responses such as perspiration, fainting, or "shock." Other common organic patterns of sensation we recognize as feelings of hunger, thirst, nausea, suffocation, oppression, and the like.

Summary

From the psychological point of view, the experiences derived from the simpler senses fall into three classes. The taste qualities which form the taste tetrahedron, the odors which form the smell prism, and the somesthetic or pressury sensations. For all these senses there are several specialized receptor cells. For all of them there is adaptation when stimulation persists for any length of time; for some of them there are positive aftereffects, and for some, negative aftereffects.

All of the simpler senses enter into conscious mental activity to a much smaller extent than do the senses of seeing and hearing, although the variety of experiences that they provide is by no means limited. Stimulation of these senses is highly important from the standpoint of bodily well-being, even if the responses aroused by them are often unconscious and automatic.

Questions

1. Analyze the sensory experiences, as you remember them, that are derived from eating the following stimulus objects, into taste, smell, tactual, kinesthetic, and other components: warm buttered toast; hot coffee with cream and sugar; lemonade; a lump of ice; taffy.
2. What is the importance of "qualitative figures" like the smell prism and the color solid?
3. If you have studied chemistry, suggest the probable sources of sweet, salty, sour, and bitter stimulation.
4. Why is it significant that most inorganic chemicals are odorless while many organic ones are not?
5. Try to distinguish speech sounds and music by placing your finger tips against a radio in action. Do the deaf actually *hear* through their finger tips? Explain.

6. Many of the simpler senses have merely unconscious or vaguely conscious results. Place them in probable rank order in this respect, the most unconscious sense being placed first.

7. The kinesthetic sense is in reality the so-called "sixth sense." Explain.

8. Discuss the importance of the static sense for aviators, submarine operators, elevator operators, and sailors.

9. Why is it difficult for us to locate and interpret the source of organic stimulation?

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CHAPTER XIII

Observing

THE MOST obvious use of the senses is that of making observations. By observation we become aware of things going on at the moment. It is clear to the most casual observer of mental activity that no individual makes complete use of the sensory stimulation that he receives at any one moment. An overabundance of material is furnished to the brain during the entire period one is awake. Each individual is literally immersed in a sea of stimulating forces, both from without and within. Yet our powers of observation are so limited that, roughly speaking, we can observe only one thing at a time. Most sensory stimulation passes completely unnoticed. Some of it produces entirely unconscious effects in the nervous system; some of it produces effects of which we are but dimly aware; and some of it produces mental activity that is highly conscious.

Preparation to Observe: Attention

The Nature of Attention. At the present moment, as you read these words, you are eye-minded, that is, you favor the stimulation coming to your visual receptors. Until you are reminded of your somewhat uncomfortable chair or of a possible pinching shoe or perhaps a lame neck, the somesthetic sensations coming from those sources are weak in comparison to what you are seeing, if indeed they exist for you at all. Stop in-

stantly and listen to the most interesting sound in the room. The words on this page then fade out, at least momentarily.

The point is that even though the sensory stimulation of the moment remains constant, some stimuli usurp the center of the stage, and others are forced into the background. There is a continual selection going on. *This process of selection of what one is going to observe goes by the name of attention.*

The process of selection usually includes a preparatory set to observe one thing rather than another. The set to observe may be very general, or it may be quite specific. One can be alert to his external environment in general, ready to use all the senses that are receptive to outside stimuli. One can limit his alertness to one sense at a time, as in looking or listening, or in palping an object by running his finger tips over it. One can restrict the alertness still more, selecting a more limited set of receptors, as in looking for irregularities in the period at the end of this sentence. For a moment nearly all other visual stimuli lose their potency, even though they are very close to the period. In a mass of sounds one can "tune" his ear to one particular tone, as in analyzing an overtone from a complex tone. Here, selection is narrowed down to a single item of sensory experience. One could carry the restriction of his observation still further by paying strict attention to only one aspect of that overtone, its loudness, pitch, or its timbre.

All of these examples of selection come under the heading of attention. Attention is, therefore, not a thing or a power that makes selection possible; it is the process of selection itself. When in popular language we speak of "concentration of the attention," we really mean that there is a very narrow range of selection and that this selection is long sustained.

The Motor Aspects of Attention. Attention involves both sensory and motor aspects. It can be observed in the other person who is attending, and also introspectively in one's self. What do we see in the other person while he is attending? Let us say that he is intent upon listening to a faint call from a distance. The total picture is one of adjusting his sense organs for the best possible reception and the avoidance of competing sensations that may interfere. His body is oriented in the direction from which

he expects the sound. His head may be turned or "cocked," with his better ear in the direction of the stimulus to come. He remains motionless. His breathing is, for the moment, reduced or suspended, as if to minimize the effect of breathing sounds or of kinesthetic stimulation.

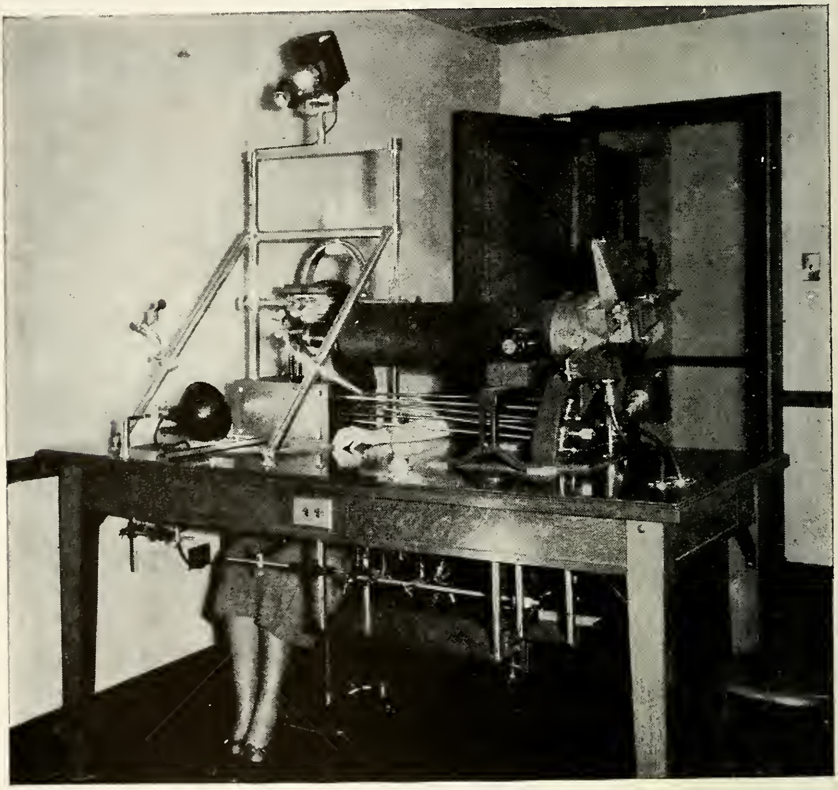

FIGURE 13.1. A camera constructed for photographing continuously the eyes of a reader or observer. (Courtesy of G. T. Buswell.)

There is usually a general muscular tenseness, depending upon the amount of effort required in shutting out interfering stimuli, and also depending upon whether there is an accompanying set or preparation to make a muscular response to the expected stimulus.

Adjustment of Sense Organs. In visual attention, the eyes are turned toward the inspected object, or they shift about with an open, "bright," alert look. This is adjustment of sense organs.

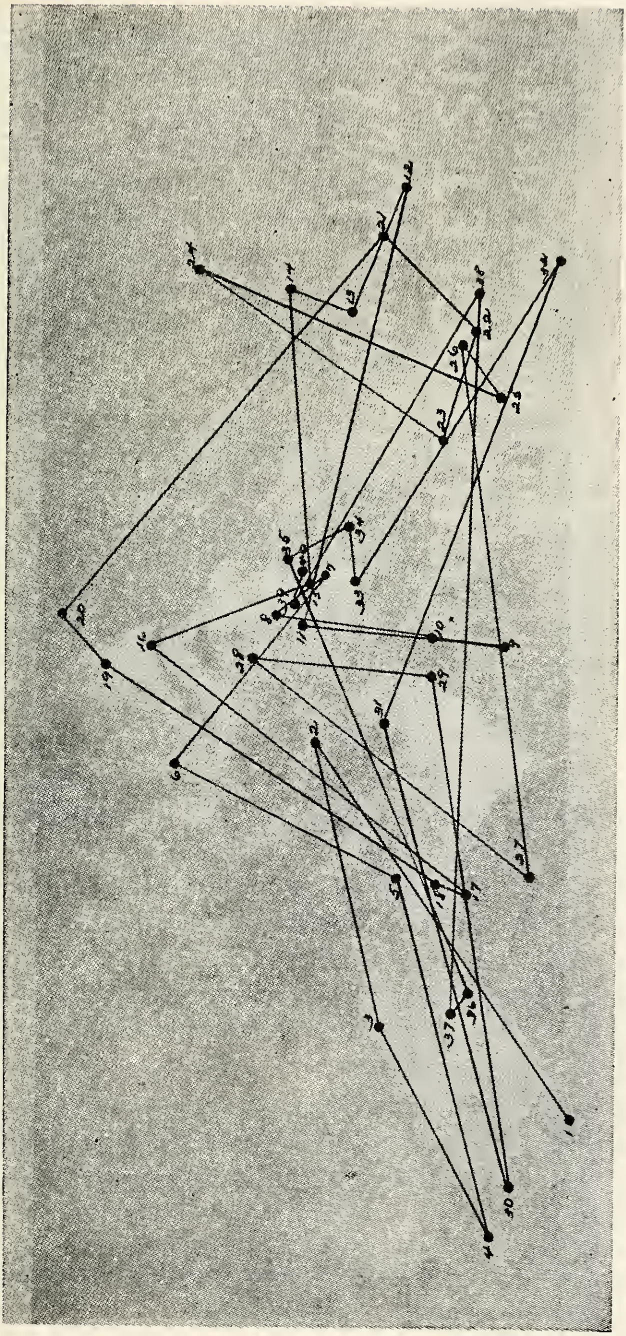

FIGURE 13.2. Eye movements and fixations of an observer while looking at an advertisement. The fixations are numbered in consecutive order. (From G. T. Buswell, *How People Look at Pictures*, The University of Chicago Press.)

Visual attention also involves adjustments of the sense organ itself for better seeing. The ciliary muscles and the muscles in the iris are alert to calls for efficient adjustments and to quick shifts in adjustment. The middle ear, with its tensor muscles, may also make some favorable adjustments for better hearing when a better selection demands it. Other sense organs have little in the way of adjusting mechanisms, although attention to a spot on the skin is accompanied by a slight rise in the temperature there, with improved circulation of blood. Attention to one sense seems to have a general "tuning up" effect, improving the acuity of other senses slightly at the same time.

Nervous Adjustments. Whether there are also adjustments within or at the receptor cells themselves is not known. The most drastic adjustment of all must be made in the brain itself. Just what occurs there to "tune in" one set of sensory excitations and to "tune out" others, we do not know. When one brain activity is increased by other brain activities, we apply the term *facilitation;* and when one brain activity is weakened or entirely killed by others, we apply the term *inhibition.* But these are merely general, descriptive names and do not really explain the "tuning" processes that occur in attention.

Determiners of Attention. The most important question in connection with the process of attention is what factors determine the selection of stimuli. It is only reasonable that the stimuli that secure the right of way entering the brain are going to be the ones that determine the activity to follow. Excitations not favored by selection either die an early death or exert but feeble influence in the higher nervous centers. The selected excitations are much more likely to produce perceptions, thoughts, feelings, and actions, and through these effects they leave permanent changes in the individual, through learning. He who would control the actions and the development of others must first of all get their attention, whether he be teacher, salesman, advertiser, or preacher. He who would control his own attention must understand what factors dominate it.

The factors that determine which stimuli will be favored may be divided, for convenience, into the external and the internal

factors, which, taken together, are sometimes called the *conditions of attention*. Some stimuli, because of their own properties, hold an initial advantage over others. They may force themselves upon us in spite of anything we may do. But to a large extent, certain factors in ourselves fortunately choose otherwise. Our attention is not merely a victim of external forces. The distinction between external and internal conditions is not complete, for the reason that we are so constructed internally as to be more responsive to some kinds of external stimuli than to others. The distinction is merely a practical one, in that we can control attention either by manipulating the stimuli or the individual; the external factors or the internal ones.

Some External Determining Factors. A list of the more important external conditions of attention follows:

(1) *The Kind of Stimulus.* We are habitually eye-minded or ear-minded; visual and auditory stimuli usually have a general right of way over others. Within these senses certain qualities may have some advantage, for example, the colors orange and yellow. Colored advertisements are said to have an advantage over colorless ones, although their advantage in getting and holding attention is probably very slight. The effectiveness of colors is less a matter of color, as such, as it is a matter of contrast with the background, or of novelty. The same is probably true with regard to favored sounds. But some sensations, for example certain odors and the feeling of pain, may be insistent because of their vital importance to the organism. The biological basis for choice of stimuli can be noticed more clearly in the responses of lower animals. Bees, butterflies, and other species select or find food or mate by depending upon some outstanding quality of the object.

(2) *The Intensity of the Stimulus.* It is common observation that bright lights, loud sounds, excruciating pains, and other intense sensations come to the fore. Intense stimulation demands adjustments for the sake of comfort if not for survival. If there are exceptions, that is, if the attention value of a stimulus is not always directly proportional to its intensity, then some other factor has entered to interfere. Like most general laws in psy-

chology, or in any field, one should begin the statement of a law by saying, "Everything else being equal." Everything else being equal, the more intense the stimulus, the greater its attention value.

(3) *The Size of the Stimulus.* Large objects, voluminous sounds, and somesthetic sensations are favored in attention. Large objects excite more receptors, and so, as in the case of intense stimuli, send more excitations to the brain per second. In both cases, discomfort or even danger is threatened, and therefore these excitations have the right of way, for the moment, at least.

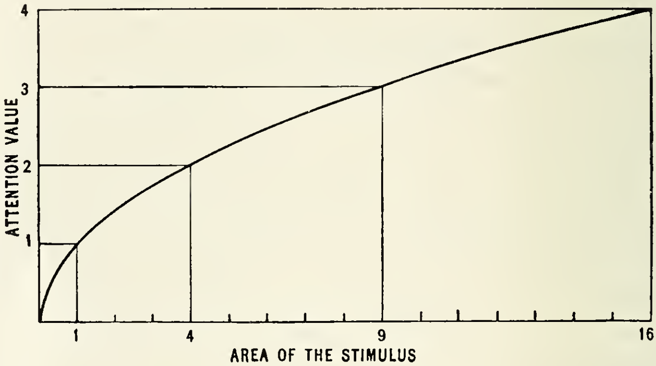

FIGURE 13.3. Diagram showing the relationship between the size of a stimulus and its attention value.

In advertising, this factor has been studied extensively. It has been shown, again and again, that the attention value of an advertisement is directly proportional to the square root of its area. A full-page advertisement is only two times as effective for getting and holding attention as a quarter-page advertisement, not four times.

(4) *The Duration of the Stimulus and Repetition.* At first a stimulus may not succeed in getting the right of way, but if it persists long enough, its chances of success are much improved. Attention is continually shifting. There will come a more favorable moment for the persisting stimulus, even though it may be lacking in intensity or size.

The chances are even better if the stimulus is a repeated one,

which is to say that its duration is interrupted. This is because, in most cases, adaptation sets in for a continued stimulus, and because another factor, change, enters in for the repeated stimulus. Decorators and musicians make use of this factor by introducing recurring patterns in their compositions. Orators introduce alliteration, and also recurring catch phrases. The greatest effect of repetition is obtained when slight variations are introduced. While repetition and duration are effective factors for catching attention, either is deadly if it is overdone. Both are usually poor factors for holding attention.

(5) *The Position of the Stimulus.* Will any part of the visual field be favored in attention? Where on a page of advertising matter or on a billboard will the observation of an average person be centered?

It has been shown that in magazine advertisements, the normal observer favors the upper half of the page over the lower, and the left half over the right. How much of this is due to normal reading habits is hard to say. With other stimuli, where reading is not demanded, the left side of the field is still favored, at least in right-handed individuals, but the lower left part may have an advantage over the upper left. In the case of attention to billboards, as set up in the laboratory, the lower part of the field just below the fixation point is favored over the upper part.

(6) *Isolation of the Stimulus.* Isolation means lack of competition for the use of the cortex, and lack of confusion with other details. Some advertisers clutter up their pages with so much material that little of it is clearly noticed. Some leave wide margins, and present one unencumbered object to compete for the reader's attention. A quarter-page advertisement displayed on a half page with clean border showed an average gain in attention value of 30 per cent.

(7) *Change.* In a sense, every stimulation is a change; it upsets some state of equilibrium in the organism. But relatively unchanging stimuli, once they are applied, lead to sensory adaptation. Even before complete adaptation occurs they lose their hold on attention. Attention shifts to something else. Some stimuli, when they are applied, mean a greater change in the nervous

processes than others. The equilibrium is more rudely upset. The greater the change, and the more abrupt, the greater the chances for catching and holding attention.

You lose awareness of the smooth purring of your motor car as you speed along, but let ever so slight a change in this sound occur and you may be immediately alert to it. You become oblivious to the ticking of the clock in the room, but let the sound stop suddenly, and your attention is called to it. Thus, cessation of a stimulus, or even a change downward in intensity or in size, is an effective determiner of attention.

(8) *Movement.* Movement is a form of change in that an object changes position in space, but it is worth mentioning in its own right. Moving stimuli have a powerful influence on the brain. Moving objects have potential danger. So long as an object remains in place, it is regarded as relatively harmless. The periphery of the retina seems especially tuned to respond to moving stimuli and to arouse the vigilance of the organism.

Some higher animals, when in combat, lash their tails about as if to distract the attention of their opponents. Feigned movements of limbs and head also have their distracting effect. Moving electric-light signs have a much greater advantage than stationary ones. When one is trying to "concentrate" on work it will help some to eliminate moving objects in the periphery of the visual field. The magician makes much use of the factor of movement. The hand is not "quicker than the eye." He simply keeps your attention fixed on some movement that seems important as a part of his trick, but which is merely incidental. While you are watching his right hand, his left hand is really performing the trick.

The Internal Determiners of Attention. The internal determiners of attention are many; too many to be discussed in full here. The most obvious determiners can be included under the term *mental set.*

As an example of mental set, let us take a typical laboratory experiment. A large white card is prepared with a great many familiar objects drawn scattered over it. There are 13 geometric forms—triangles, hexagons, parallelograms, and the like, each one in a different color. There are 13 black letters and 13 black two-

place numbers. A group of students are told that when the card is exposed to their view, they have five seconds in which they are to notice as many colors as they can, for they are to write a list of all the color names they can remember after the exposure is over.

For 57 students who served as subjects, the average number of colors reported was 6.3. Immediately after the exposure, the students were instructed to list, also, the names of any forms and anything else they noticed. The average number of forms listed was only 3.3, or about half the number of colors, although form and color belonged to the very same objects. Forty per cent of the subjects stated they did not see any number at all, and many more could not name any numbers. Fifty-four per cent saw no letters, and some who did observe that there were letters present, could not name any. As to size and intensity, in contrast with the background the letters and numbers were larger and more intense. Yet the mental set "to notice colors" produced a highly selective result, even in opposition to external factors. This is but one of innumerable examples in which a mental set is the most powerful determining factor for attention.

What determines mental set? In this particular experiment, the verbal instructions of the experimenter aroused the mental set for attention. In everyday life we rarely have such specific instructions, though all workers who have supervisors are continually receiving such instructions. For the most part, a mental set arises in a more natural manner. Its history is a very complicated matter that takes us into the field of motivation, which was discussed in earlier chapters.

Attention determined by internal motives of a positive sort, we may say is due to interest. We are interested in objects that gratify our organic needs, that appeal to our curiosity, or that satisfy any other personal demand. The types of interest already mentioned rest more directly upon innate or inborn motives. Human interests also include very many that are acquired by the individual, and these depend upon education and training. We develop habitual mental sets that determine what we look for. The primitive man, acting as guide to a civilized safari in Africa, notices sights and sound and odors that the civilized man entirely

overlooks. This is not because his senses are any more acute, but because he is trained to be receptive to the significant things.

An old hunter or trapper, likewise, notices things to which his friend, who is a novice, is entirely oblivious until they are pointed out to him. He simply does not know where to look or how to select. Suppose a botanist, a geologist, and a psychologist are walking in a zoological park. The botanist, from long experience, is tuned to observe the flowers and shrubs, the geologist notices the natural rock formations, and the psychologist notes the behavior of the animals behind the bars and also of those in front. A great share of any individual's education consists in developing the management of his attention. This makes him a better observer, and creates new and deep interests.

Distraction. A distractor is best defined as any factor that normally tends to break up sustained attention. In a more popular sense, the disturbing element interferes with what the individual wishes to do at the moment. It is thus usually an external factor, and it interferes with the selection already set up by internal factors.

Some Distractors Not a Hindrance. Distractors are not by any means always detrimental to mental output. Experiments have shown, very surprisingly at first, that an individual may actually improve in mental output under the influence of distracting stimuli. It is generally assumed that the degree of attention of an individual during mental work may be measured by his output in terms of speed and accuracy when the kind of work requires close attention in order to do it at all. For example, Morgan required his subjects to react by pressing a key with one finger when a color suddenly appeared. This automatically exposed another color for which the subject had to make a reaction with a different key, and so on. The task was complicated even more than that so that it could not become automatic. After a subject had begun his series of reactions, very loud sounds, like the ringing of fire gongs, buzzers, and phonograph music, were turned on and off in haphazard order. At first the subjects were badly disturbed and reacted more slowly. Soon, however, they brought their performance up to normal and even above normal. But this was done at a

much greater cost of energy, as shown by the fact that they exerted more muscular effort in pressing the keys. Records of their breathing showed increased intake of oxygen and a change in the rhythm of breathing, such as occurs when one talks to himself.[1]

Adaptation to Distraction. With continued periods of work under distraction it is found that the expenditure of energy decreases. This shows that individuals can become habituated or adapted to working under distraction. When the distractors are suddenly removed the individuals again lose in output for a time before becoming adapted once more to quiet surroundings. It is doubtful, however, whether anyone ever becomes so fully adapted to distracting stimuli that the energy cost is no greater than without those distractors. And no one would actually bring his performance under distraction up to his level without distraction. unless he were strongly motivated to do so. Morgan's subjects were found to have a certain standard of speed in mind, and they put forth the necessary additional effort in order to attain that standard.

In another experiment involving 19 minutes of concentrated mental work on a mental test, two groups of students of comparable initial ability in the test were tested, one in a quiet room and the other in a room literally swamped with visual and auditory distracting stimuli. The average score was 137.6 for the control group (working in quiet conditions) and that for the experimental (distracted) group was 133.9. The average loss to be attributed to the distractions was only 3.7 points, a trifling difference. Some individuals lost more and some less. No doubt the experimental group expended much the more energy that expressed itself later in the form of strained eyes and stiff necks.[2] Under similar conditions another experimenter found an increased expenditure of about 60 per cent, with some saving in this after a few days of adaptation to such working conditions.[3]

What Makes Distractors Effective? Certain other facts concerning distraction are worth noting. In general, sound stimuli are greater distractors than are light or tactual stimuli. A distractor is more potent if coming in the same sense as the stimuli to which we are trying to attend; sounds are more distracting while listen-

ing; lights while seeing, and so on.[4] Interrupted or varying stimuli are stronger distractors than are continuous or unchanging ones, as the factor of change would lead us to expect.

The set or attitude of the individual has much to do with the effectiveness of the distractor. An active or positive attitude toward the task to which we wish to attend is usually much better than a negative attitude toward the distractor. By attempting to force the distractor out, we are paying attention to it. Appealing distractors are more potent than other stimuli, because they gain internal factors as allies on their side. For example, interesting anecdotes are found more effective for the average person than music.[5]

Division of Attention. Can attention be divided between two distinct tasks at the same moment? Can there be two separate foci of conscious activity at the same instant? This is not a question of carrying on more than one activity at a time, for we often do that. We can talk while we walk and, at the same time, continue breathing. The question is whether two tasks both requiring close observation can share the limelight simultaneously. For example, can one count marbles with one hand while using the other hand to dot letters as they come in quick succession into a small opening? And can he perform each task as rapidly and accurately as if each were done alone? And, if he succeeds, how does he manage to take care of the two tasks?

This problem is of considerable importance to individuals who must operate very complicated machinery. Aircraft pilots, for example, must be alert to many sights, sounds, and feelings and must give attention to a number of tasks simultaneously on many occasions.

How Two Tasks Can Be Performed at Once. Experiments with double tasks show that there is no consistent general ability in individuals for performing pairs of tasks together successfully. It depends upon the tasks, and how much practice the person has had in them separately or together. The ability to improve in this respect depends to some extent upon the intelligence of the individual. There are four ways in which two simultaneous tasks may be successfully performed together:

(1) Attention shifts back and forth between the two tasks. Suppose you were asked to count backward by threes beginning with 820 and at the same time to write the word "university" backwards as rapidly as you can. You would probably tend to alternate the two, counting for a short time, then writing for a time. You might be able to oscillate back and forth between the two rapidly enough that each task would be carried forward under its own momentum during the shifts away from it.

(2) One task may be more or less automatic if you have had any practice in it or in a similar task, or, as you proceed, one task becomes automatized. Attention is then kept more completely upon the less automatic task.

(3) The two tasks may be combined into a single rhythm or pattern. Learning to play the piano is an example of this. After learning first to play with each hand alone, when first playing with both hands together, the one activity disturbs the other. Gradually the two come to move together in an organized pattern to which attention can be given as to one thing.

(4) Finally, there seem to be real cases in which the two tasks remain separate,[6] neither becoming automatic, and yet attention seems not to shift between them. The stage performer who stands on his head, answers questions, solves two or more problems in arithmetic with hands and feet simultaneously, may have acquired, through training, a genuine knack of separating the tasks and yet attending to them. Laboratory tests seem to show that this true case of division of attention can occur. But even here, one of the two simultaneous tasks is carried on in a more passive way resembling some degree of habituation.

The best results are usually obtained by performing one of the two tasks automatically, or by combining the two.

Control of Attention. The facts of this chapter, if applied, should go a long way to help a person control his own attention, as well as that of others. Those who complain that they "cannot concentrate" would do well to think how each fact may apply to themselves.

Self-directed attention is a matter of marshaling the necessary motivation and directing it in the right way. Having one or more large, important goals is very important. It makes unfulfilled minor goals seem unimportant. Thomas A. Edison had no difficulty in giving absorbed attention to his tasks for long periods of time. An all-absorbing interest is the secret of the sustained efforts of those who have achieved greatness. Many such goals are vocational. If you should be lacking definite ideas of vocational plans for yourself, you could probably obtain help from a competent vocational counselor.

The best way to handle distracting stimuli is to eliminate them from your environment where that is possible, or to move to a less distracting environment. Work in a comfortable, quiet place, with or without the presence of other persons, depending upon whether they facilitate or hinder your efforts. If there must be neighboring disturbances, form habits of ignoring them. But do not try to buck powerful distractions. It costs too much nervous energy. If the detracting forces are in the form of unsatisfied cravings, decide which ones should be fulfilled right now, which ones should be postponed, and which ones should be denied. Be realistic about getting what things you want and when you should get them. Weigh them all against your major life goal or goals.

Meaning

Making an observation is an act of perception. Perceiving involves organizing sensory excitations and developing meanings. In a previous chapter the principles of sensory organization were discussed, with illustrations from visual perception. Here we will complete the picture by seeing how meanings are obtained.

The Problem of Meaning. Organization and meaning go hand in hand. Meaning depends upon organization, and it also helps to organize. Every organized whole has at least some meaning. Fig. 13.4 is an illustration. Of 754 school children from grades 3 to 9, only 7 per cent saw the "correct" or intended object, although many gave other meaningful names for it.[7] Many

organized it as the face of various animals. After they were told that it represented the face of a man, in other words, after they attached a definite meaning to it, the correct organization was much easier to attain.

Similar experiences are common in the novice who uses the microscope for the first time. He fails to make anything out of the mass of sensory material given him by his eyes. An instructor describes to him what he should see, shows him pictures organized like the elusive specimen under the microscope, and then the proper organization jumps out for the observer, just as do the hidden objects in a puzzle picture.

FIGURE 13.4. A figure that is difficult to organize. Explanation in the text. (From R. F. Street, *A Gestalt Completion Test*, Bureau of Publications, Teachers College, Columbia University.)

Organization Usually Precedes Meaning. Sensory organization, however, is usually prior to meaning, and can be independent of meaning. One organizes many objects of perception long before he realizes their full meaning or significance, if indeed he ever learns their complete significance. The visual perception of those individuals who were born blind, and who, by means of an operation, gain the use of their eyes in later life, furnishes striking proof of this point. One might suppose that, their vision restored, they could then "see" as well as anyone else. This is far from true. For them, some visual organization is possible immediately, but much must be learned. Relatively large and conspicuous objects stand out from one another, and from the background on which they appear, but finer details or complex patterns appear only with some practice gained in manipulating them. Very familiar objects and persons, even close friends, are not recognized by sight until they are sensed at the same time by hearing, touching, or smelling.

Meaning Depends upon Relationships. Nothing has meaning unless it refers to something beyond itself. If you should see a small, round spot of red upon the sidewalk near your doorstep it might mean a number of things. It might be blood, it might be paint, or it might be a bit of lipstick. All three are something more than a spot of red. Which particular meaning is correct will depend upon the entire situation. If a painter had recently been painting the roof red, your brain would be likely to make the spot into red paint. If, on the other hand, you saw a wounded bird fluttering across the lawn, the concept, "blood," might be the one to arise. If your younger sister had been clumsily experimenting with lipstick on the front walk the evening before, the third alternative would arise spontaneously. Meaning, then, goes beyond the immediate sensory experience—a red spot in this case—and what meaning is suggested depends upon the context of that experience.

Meaning Depends upon Past Experience. In past experience lies the secret of most meanings. Meaning depends upon associated experiences, and it must be built up, in human beings at least, almost completely by learning. In lower animals meanings may be innate or inborn, if we define meaning broadly enough. For example, a bird reacts instinctively, without apparent learning, to sticks and straws and mud, in building her nest, just as if she knew their use. Admitting this example to be a case of meaning, we may say that *meaning consists of any definite adaptive reaction to an object which shows that the individual expects something of it.* Men are born with extremely few adaptive adjustments to any stimuli. In both man and lower animals, however, much power of sensory organization is inborn, and some organizations seem to come quite naturally as if without learning. In both, further organization is made possible by learning.

The Sense of Reality. While it is true that we create our own sensory organizations, and to that extent they are subjective, we proceed under a conviction that they stand for or are something "real" and independent of us. We usually distinguish, if we are normal, between our perceptions on the one hand, and things we "just imagine," on the other. The books, lights, and persons

standing before us we do not deny, for we say, "seeing is believing." But seeing a ghostly pillar of light standing by our side in the dark would not convince us of its reality until we could put out a hand and touch it, or could hear it speak. We check on one sense with another; for when two or more senses agree, we are convinced that the object reported by them is real. It is harder to trick two or more senses than one at a time.

Illusions and Hallucinations. Some perceptions are distorted or even created by internal desires and cravings. A mere distortion of reality is called an *illusion,* while a *hallucination* is a complete fabrication. The squeaking of a door may become a scolding voice or a cry of pain. A fluttering scrap of newspaper at the roadside at night may become a dangerous animal. All "sound effects" in radio and some in movies are illusions very skillfully presented—the roar of the storm, the purring of a motor car, the tramping of marching feet, and clatter of horses' hoofs; all are clever imitations, mechanically produced. Magicians and spiritualistic mediums, in their many staged performances, are past masters in the art of creating illusions.

All illusions rest upon at least a bit of sensory stimulation. Hallucinations are supposed to be one hundred per cent fiction, though, even in them, some sensory basis may be present. The wanderer, dying of thirst in the desert, sees a lake of promising water just ahead, only to find that it vanishes at his approach. Most of us have dreams that are so vivid and realistic while they last that we are often thankful when they are over and we awaken to realize that they are not genuine occurrences. Some daydreams may become so vivid as to be mistaken for reality, and, if they do, we can correctly call them hallucinations.

We often perceive what we want to perceive or expect to perceive rather than what the real situation dictates. Every perception is, in a sense, a compromise between the effects of external stimulation and internal desire. When the balance is too badly upset in favor of internal motives, stern reality ordinarily brings us to our senses with a jerk. But some persons find reality so disagreeable or painful that they lose their criteria for distinguishing between the real and the unreal. They live in an organized world more completely of their own making. We call them insane. Re-

acting to their own private worlds, they do queer things. They may seem to misinterpret everything around them. If we also were to organize our own private worlds along the same lines, however, our interpretations and actions would be very similar to theirs.

This is not the place to discuss how the sense of reality is developed. Suffice it to say that what an individual does is directly dependent upon how he organizes his private world. The key to this organization is sense perception. An understanding of how the individual's sensory organization is brought about under the influence of external stimulating factors and internal factors of wants and needs should illuminate much of his total behavior.

Reading. The act of reading affords excellent illustration of many facts of attention and perception. The attention of the reader can be followed by noting his eye movements as his fixation shifts along the printed line and back to the beginning of the next line. Eye movements are necessary because good pattern vision is limited to the small, central part of the visual field corresponding to the foveal region of the retina. Shorter than the span of good pattern vision is the *span of apprehension,* that is, the amount of meaningful material the reader can take in at a single glance. This is usually not over two or three words, depending upon the familiarity of the material.

Eye Movements in Reading. Numerous studies have been made of reading, in particular of the behavior of the eyes of the reader. The eye movements are recorded by means of a special camera that contains a moving film which is focused upon a tiny spot of light on each eye. When the eye remains stationary, a straight line is traced. A movement leaves a break or wave in the record (see Fig. 13.5).

The results show that the eyes are not moving continuously along a line of print, as was previously believed, but that more than 90 per cent of the time the eyes are fixed and non-moving. Only when the eye is stationary can any perceiving take place. It moves with a sudden jerk, known as a *saccadic movement.* During this movement so much variation of light passes over the retina that the eye is practically blind. The interval between fixations

is so very brief that we do not notice it. You can demonstrate these facts to yourself by looking in a mirror. Look first at your right eye and then at your left. You cannot detect the transition from the one fixation to the other. All you see are the two stationary views of your two eyes; you cannot see your own eyes in motion.

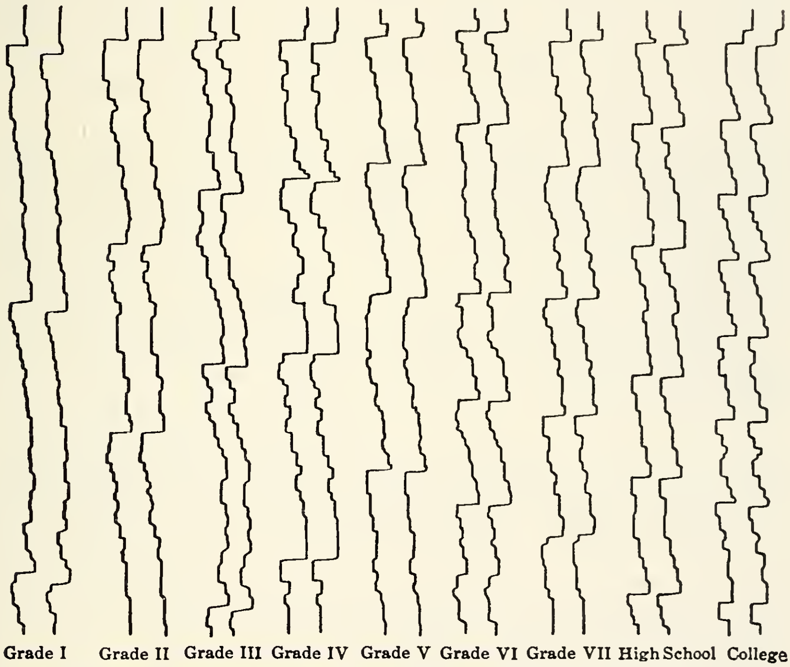

FIGURE 13.5. The photographic records of eye movements of an individual at different stages of development. The growth is shown by: Fewer fixations per line; shorter fixation times; more rhythmical patterns; and fewer regressive movements for re-reading. (From E. A. Taylor, *Controlled Reading*, The University of Chicago Press.)

Good readers make few stops along the line of print, which means that they take in more than the average person at each fixation; they have a larger span of apprehension. They also show fewer retracings, that is, they rarely have to go back again to pick up something overlooked or immediately forgotten. The records of eye movements are, therefore, indicators of good or poor reading habits. Fig. 13.5 shows how the reading habits of a certain

girl improved as she went through the grades. As she progressed through school she improved her span, she resorted to fewer retracings, and developed a smoother rhythm of movements along the line.

The Span of Apprehension. The term "apprehension" refers to the grasping of meaning. The *span of apprehension* is the amount of information an observer can grasp from a complex stimulus at a single, momentary exposure. By means of special apparatus one can expose to an observer, for a fraction of a second, a small card upon which are a number of simple objects. The time of the exposure is brief enough to prevent an eye movement so that whatever the observer sees he must grasp at a single glance. The number of objects may be varied from one to twelve or more. They may be simply dots, or they may be letters, digits, words, or geometric forms in colors. The observer may be asked to report the number of objects, to name the objects, or to describe them.

Accepting only those responses that are completely correct, we find that the observer's success varies from time to time. At one moment he can report correctly upon eight objects, and at another moment he fails with only four. The typical observer fails more and more as the number of objects increases, until he always fails. We take the number of objects that he can report correctly 50 per cent of the time as the measure of his *span of apprehension*. The size of the span varies according to the individual and according to the kind of report requested. Merely counting is easier than naming objects, and both are easier than describing color or form. Some typical spans of apprehension are given in Table 13.1.

TABLE 13.1.—SPANS OF APPREHENSION FOR COUNTING, NAMING, AND DESCRIBING *

Kind of Report	*Observer*		
	D	G	H
Counting	11.3	9.2	6.2
Naming letters	7.9	6.9	5.9
Naming forms	4.3	3.2	3.9
Describing forms	3.3	3.0	3.3

* From Glanville and Dallenbach.[8]

The importance of the span of apprehension is seen when one tries to read license-plate numbers, telephone numbers, and other

series of digits or letters that often have to be grasped at a single glance. Fortunately, we usually get more than a glance at such material. Grouping items is an important aid in enlarging one's span. Longer license numbers or telephone numbers are divided by dashes or by using letters or words. In ordinary reading, for efficient work, a single glance must suffice, and one has to adjust his eye movements to that number of words that can be apprehended 100 per cent of the time.

Some Special Types of Perception

The discussion of perception thus far has referred almost entirely to objects of one kind or another. Exceptions have been in the few references to speech, oral or written, and to space as perceived by some of the senses. There are many other types of things that we observe. We cannot cover all of them in an introduction to psychology. There are three other types of observation, however, that cannot be ignored, because of their general interest. These include observations of time, of social objects and situations, and of one's self.

The Perception of Time. Psychologists have found that it pays to make a distinction between observations of short time intervals and long time intervals. Behavior is rather different in the two instances.

The Perception of Short Intervals. Short intervals of time are less than ten seconds. In a scientific study of these intervals observers are asked to compare two successive intervals, or to keep moving in step with a succession of stimuli coming in a regular rhythm, or to reproduce a single interval. Results show that their errors are least for intervals from 0.6 second to 0.9 second, depending upon the method. The value of 0.75 second is usually given as the indifference interval, because intervals below that value are usually overestimated, and intervals above it are underestimated. It is easiest to beat a spontaneous rhythm of about this rate, which would be 80 beats to the minute. This rate is close to normal pulse time, or marching time. One can adapt himself fairly well to rhythms with intervals varying from 0.5 second to 1.00 second.[9]

The Judgment of Longer Intervals. In the perception of a short time interval, attention can be given rather continuously to duration itself. During longer intervals attention is bound to wander, and the judgments are based upon more indirect cues These cues include almost any dependable signs of passing time, for example, the number of events during the interval, the sum total of accumulated experience, and the like. These cues can often be misleading, and we consequently make great errors.

A person who has fallen in a faint wakens a few minutes later with the impression that no time at all has passed. Since no events have occurred for him between fainting and awakening, he naturally concludes that no time has elapsed. On the other hand, soldiers keyed up in the morning for a battle, may be in the thick of events all day without realizing that a day has passed, until they become aware of the setting sun. The last illustration shows that in order to appreciate the temporal aspect of our experience, some attention must be given to its observation or it will be missed, in the same manner as any other unattended aspect is missed.

Experiments on intervals from 10 to 200 seconds have shown that the duration of time is overestimated during monotonous and passive activities, such as simply waiting, and it is underestimated during intervals in which much happens, or in which the person is active. Tensions, strains, and emotions tend to cause underestimation. Intervals that seem to pass quickly at the time may seem long as you remember them, and some that pass slowly seem short as you remember them.

Judgment of Time During Sleep. Many people have the surprising gift of waking during the night at a time decided upon before going to sleep without the aid of an alarm clock. Many experiments upon this point have revealed some of the facts about it. Success varies with the sex and age of the sleeper, the time of year, and other factors. It is easier in summer that in winter, probably because the early dawn in summer furnishes more visual cues. The accuracy increases as the time decided upon approaches the person's normal waking time.[10] The normal waking time is usually determined by sensations of hunger, thirst, full bladder, rested conditions, etc. All this means that there is probably no

mysterious, unconscious counting of time, but that the individual really sets himself to respond to stimuli, mostly within himself, even without realizing it.

The Appreciation of Time by Children. It is common experience that as one grows older time seems to pass more rapidly. To a child an hour or a day is sometimes an interminable stretch of existence; to the aged the dwindling days speed by. A suggestion has been made that the apparent length of a time interval at your present age is judged on the background of all the time you have lived preceding the present moment.[11] To a child of ten, a year should seem two times as long as to a youth of 20 and five times as long as to a middle-aged person of 50. The change is probably not that drastic or that regular, but there is a general change, nevertheless.

Is There a Special Time Sense? Certain facts seem to point to a special device for recording time by the brain. One theory is that the brain "counts" the bodily rhythms such as breathing and pulse, hunger and thirst. Although these factors may help to furnish cues about the lapse of time, it is certain that they have no very direct or dependable use as a psychological clockwork.

Hoagland has concluded that we possess a "chemical clock" that marks time for us. Facts point to a chemical change in brain cells, probably related to respiration, that maintains a very regular rate. During a fever the "clock" runs faster and the individual senses time as going faster in direct proportion, whether the fever is a real one, as during influenza, or an artificial one produced by diathermic treatments.[12]

du Noüy proposes the theory that the psychological appreciation of time is connected with the rate of physiological processes in general.[13] As an individual grows older the rate of metabolism slows down, as can be demonstrated by the length of time required for a wound to heal. The rate of slowing down of physiological processes is paralleled by the apparent speeding up of clock time. Clock time remains constant from infancy to old age. The rapidly living child senses clock time to be slow in comparison with his rate of metabolism; the slowly living senile senses clock time to be rapid in comparison to his slower rate of living.

While undoubtedly the psychological appreciation of time depends upon brain processes, such theories as those mentioned here can as yet only be taken as suggestive.

Social Perception. With the perception of organized wholes comes the awareness of properties of those wholes. Such is the case in our observation of other people and of social situations. In a social group we learn by experience to sense what is going on, although there may be few visible or auditory signals that we could put our fingers on as the source of our perception. Much of this goes beyond perception to the process of reasoning. Still, much of our knowledge of the situation comes directly from an organized sensory experience and its meaning. Remote stimuli are grouped together to produce a mental structure that prompts the appropriate reaction. Tactful people have the fortunate knack of knowing the right thing to do at the right time. Vague organizations of a social nature come as "hunches," more unconscious than conscious. They are made possible by dint of much social experience rather than by any special hereditary gift or "sixth" sense.

Emotional Expressions. Next to speech, emotional expressions furnish us with the most useful social stimuli. Emotional expressions are given in the bodily posture, gait, positions, and movements of arms, hands, and head, and by facial reactions. As was hinted above, our adjustments to these factors as stimuli are neither deliberate nor consciously considered. Taking all the cues we can get from another person collectively, we react to the whole. At times one emphatic element may be the crucial factor. But by taking each element separately we would not distinguish ourselves for making a correct interpretation of attitude or emotion in the other person.

Judgments of emotions in photographs of individuals showing only their faces have not been notoriously successful. If the expressions were posed by an actor with intent to portray definite emotions and attitudes, the agreements of judges are reasonably good. The expressions most easily judged correctly have been for the cruder emotions of disgust, contempt, anger, fear, surprise, and laughter. There undoubtedly is a conventionalized language of facial expressions to which we agree. Most adults can con-

ceal to some extent their real feelings, and even give misleading impressions, except in unguarded moments. When expressions are photographed under laboratory conditions, emotional reactions having been set up, it is almost impossible for the average adult to see what the real emotion was. Motion pictures bring in the dynamic, temporal pattern of an expression that might be missed in a still picture. In everyday life, too, we have not only the face but the whole body and the total situation to lend us extra hints as to what the person's real emotion is.

The hands taken alone as expressive organs give surprisingly good suggestions of emotional states. Posed expressions with hands, either in still or in motion pictures, were judged by several hundred students. The result was an agreement of about 70 per cent as to the emotion portrayed. Most easily portrayed were attitudes of prayer, pleading, thoughtfulness, surprise, and fear. In the moving pictures, determination, anxiety, warning, and satisfaction were also well portrayed. No differences in ability were found between men and women judges or between those students with dramatic training and those without.[14] Again, however, the judges were dealing with a conventional language of expression.

Personality Traits. The awareness of personality traits in others, including degree of intelligence, depends upon how much we see of them and in what connections. It has been found that photographs are just about worthless as a means of judging intelligence or any other personality trait. A photograph sent with the ordinary application for a position has no value except to tell how the applicant looks. Motion pictures may tell more about a person. Better still is the observation of a person's behavior in different kinds of situations when he does not realize that he is being observed. Worst of all methods of observing a person's traits is to use such cues as the shape of his head or his hands, the color of his hair and eyes, the lines in his hands, and other such pseudoscientific procedures.

Perception of One's Self. Each human individual organizes his perception of himself as an object. Because the individual is a very complex object, this takes much time and experience. From his own body he receives an enormous mass of somesthetic sensa-

tions of all kinds; he also hears his own voice and other sounds that he makes, and much of his body falls within his visual field. At first he undoubtedly fails to discriminate between those sensations coming from his own body and those coming from other objects. The world is more or less all of one large piece with his somesthetic sensations at the core.

A number of things may contribute to help him draw a boundary line around himself and to emerge as a separate figure from the rest of the world. It may be that one day he detects a difference between his foot and a bar of soap. Squeezing his foot with his fingers he gets feelings in both hand and foot; squeezing the soap he gets sensations only in his hand. Associated with his own voice there are feelings in his throat not present when another's voice sounds in his ears. His own hands and feet he can move; other things resist his moving them. There follows a separation of the self from the notself as one more object set against the rest of the world. The conception of self keeps on growing, and self discovery cannot be called complete until the end of the normal life span, if it ever is complete. At what age the discrimination of self first comes is hard to say, but probably between the ages of one and three years.

Summary

Out of the superabundance of stimulation at the moment, we select a limited portion, which will have the right of way in our brains. This selection is known as attention. The organism, while awake, is usually set or prepared to observe some things and not others. The preparation is expressed in terms of general muscular tenseness, adjustment of sense organs, and of some kind of nervous "tuning" to particular stimuli.

Factors both outside and inside the individual operate to force the selection that is made. Certain kinds of stimuli, the intense, the large, the repeated, the changing, and the isolated stimuli have advantages over others. Internal dispositions, coming under the general term "mental set," determine what stimuli will be admitted most fully. Temporary mental sets are in turn determined by the organism's present wants and needs; in other words, his motives, including his acquired interests.

Distracting stimuli tend to break up sustained attention; but with compensating effort an individual may be spurred to better than normal performance by them. Whether an individual is distractible in a task depends upon the kind of task as well as upon the particular person. Ordinarily, attention cannot be successfully divided between two or more simultaneous, disparate tasks both of which require attention.

The culmination of observation is meaning, for this determines what adjustment the organism makes. Meaning refers to something beyond the organized experience itself. It usually depends upon past experiences which lead us to expect other things associated with the perceived object.

The process of reading is a good example of perception. As organized patterns, words are merely arrangements of black lines on a white field. These patterns touch off meanings for those who can read.

The experience of time, like the experience of space, depends upon the well-known senses. That is, there is no "sixth sense" for either time or space. Many sensory cues enter into the picture to give us the impression of the amount of time elapsing between two points, just as sensory cues give hints of distance. Without some attention to elapsing time there is little opportunity to observe its duration, although experiments show that there is some accuracy in waking at certain set times after going to sleep. Children show some appreciation of time intervals.

Perceptions of social objects, conditions, and situations are among our most complicated observations. They involve judgments of emotional expressions, attitudes, and other characteristics in other people. Good social adjustment depends much upon the correct observations of others and of social relationships as grasped through the senses. The perception of one's self as an individual is a similar type of observation.

Questions

1. What do the muscular adjustments during attention contribute to efficient observation?

2. Turn the pages of a magazine and notice which advertisements catch and hold your attention.

3. What applications can you suggest of the square-root law of attention?

4. Show that the external determiners of attention really depend upon the make-up of the individual.

5. As you walk down a city street past shop windows, note which windows or objects catch and hold your attention. Explain on the basis of the determiners of attention.

6. What should a student do about a required school subject in which he is not interested if he wishes to complete it satisfactorily with minimum effort? Give some practical suggestions.

7. Distraction often increases output but lowers mental efficiency. Explain. Would it ever lower output? Would it ever increase efficiency? Explain.

8. What "expectations" are involved in your perception of (1) a beefsteak; (2) a desk; (3) a cloud; (4) a cat?

9. Explain: "We see things as we are, not as they are." To what extent is this true and to what extent false?

10. Why would it be valuable to have the eye-movement record of a person who is experiencing reading difficulties?

11. Show that the appreciation of time depends upon our own bodily make-up.

12. Why are social perceptions so much more likely to be in error than are perceptions of objects?

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CHAPTER XIV

Conditioned Responses

An Introduction to Learning

A little girl, not quite two years old, made a number of visits to her doctor's office. She came to take these as a matter of course, if not with pleasure. One day she was to receive her first of three inoculations against typhoid. She watched the doctor prepare the hypodermic needle and her arm with much interest. Only after the needle jabbed her arm, stimulating some pain receptors, did she show any aversion or alarm. Then the response was a mild withdrawal, a cry of pain, and some whimpering. On the second occasion she approached the doctor's office with the usual alacrity, and even entered his inner office much as usual. But upon seeing the doctor prepare his hypodermic needle she broke out crying and made movements definitely in the direction of escape. When it came time for the third inoculation, the mere sight of the outer office door was sufficient to set off the efforts to escape and the cries of fear. After the third episode, a mere mentioning of a visit to the doctor resulted in at least a mild fear reaction.

A Definition of Learning. This little story illustrates many of the basic facts of learning as we find it in its natural state. Remember that behavior is a matter of stimuli setting off their responses. Like the burned child who afterward dreads the fire, this

child learned to try to escape from a hypodermic needle, a doctor and his office, and even to react with dread when the doctor's name was mentioned. Before the painful episodes she had reacted quite differently to all those stimuli. The changes in her reactions are examples of learning. We may define the term very broadly by saying that *learning is any change in behavior, resulting from behavior.* In this we must distinguish learning from changes in behavior resulting from natural growth of a nervous structure. The latter we called maturation. The two ways of development work hand in hand. When a change in a child's behavior comes, we often have difficulty in saying whether maturation or learning has had the more to do with it. In most cases we can see that learning has contributed its share.

Learning Is Reorganization. Learning always means a reorganization of behavior. Behavior is always more or less organized. In an earlier chapter it was shown that the brain organizes incoming excitations into patterns and in another chapter it was said that responses are patterns of movement. Organizing sensory patterns is a case of learning and so is the organizing of motor patterns. The little girl of our illustration brought such patterns already organized with her to the doctor's office before the first painful episode. A third kind of organization is the connecting of sensory patterns to motor patterns where no connections existed before. This is the most obvious variety in our illustration.

Three Kinds of Learning. For logical purposes we may speak of three very general kinds of learning: (1) sensory, (2) motor, and (3) sensorimotor. The motor variety should, of course, include glandular responses, although to do so the term must be liberally interpreted. The three kinds are probably never found isolated in pure form; they occur together. In describing an actual learning event we can only say that the significant change seemed to come primarily on the sensory side of the nervous system, or on the motor side, or as a new connection between the two.

The Process of Conditioning

Pavlov's Classical Experiment. About fifty years ago, Pavlov, the Russian physiologist, began making some discov-

eries about learning that have brought about a virtual revolution in psychology. He was studying the processes of digestion, not of learning, but in doing so he made a very profound observation about learning. This started him on a life-long study of the brain and how it operates in learning. The plan of his experiments was somewhat as follows.

His laboratory animals were dogs. First, the dog to be used in his experiment was thoroughly tamed, and trained to stand patiently in its harness upon a table (see Fig. 14.1). An operation was performed upon the dog, isolating the duct of one of his salivary glands and extending it through a fistula in his lower

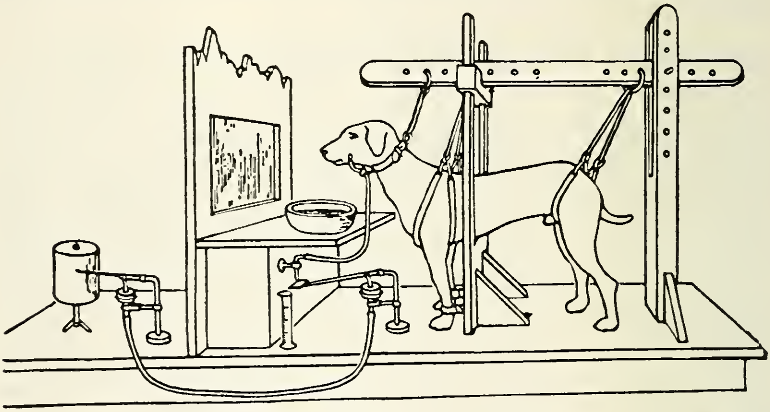

FIGURE 14.1. An experimental arrangement for studying the conditioned salivary response in dogs. (After R. M. Yerkes and S. Morgulis, in R. H. Gault and D. T. Howard, *General Psychology,* Longmans, Green and Company.)

jaw so that the saliva could be collected, drop by drop, in a glass tube. The amount of saliva secreted in a given short time interval could then be measured, or an automatic registering device could give a continuous record of the rate of flow (see Fig. 14.1).

Food could be presented automatically at any moment. No human being was in sight. Everyone knows how a hungry dog's mouth waters at the sight of food. In Pavlov's experiments an electric bell was rung by the experimenter as a signal just before food was presented. Again and again the two stimuli came in quick succession; bell-food, bell-food, bell-food, and so on. It was not long until, omitting the food stimulus entirely, the salivation

came in response to the bell alone. Before this experiment a bell resulted in little or no reaction on the part of the dog; certainly not salivation. After repeated stimulation by the bell-food combination, the bell became an adequate stimulus for salivation. A conditioned response had been formed.

The most simple interpretation of this phenomenon is that when two stimuli are presented repeatedly together, the new one first, then the original, effective one, the new one also becomes effective. There is, in other words, what appears to be a substitution of stimuli; bell becomes substituted for food. We may visualize roughly what happens in conditioning in terms of the diagram

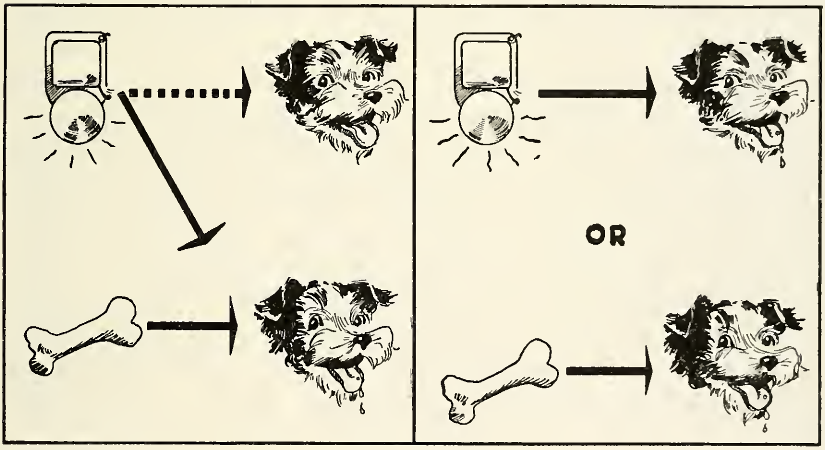

FIGURE 14.2. A highly simplified diagram of what occurs in the formation of a conditioned salivary response.

in Fig. 14.2. The entire process is, of course, more complex than that.

Factors Controlling Conditioning. This brings us to the question as to just when and why conditioning will take place. Why, for example, does not food become a substitute stimulus for bell rather than the reverse? Which of the two stimuli should be given first and how far apart in time can they be given and still cause conditioning? How many repetitions of the old and the new stimuli in combination are necessary?

(1) *Dominance of the Response.* Before Pavlov's dog had learned to salivate in response to the bell, the bell undoubtedly aroused some response. The dog naturally pricked up his ears, showed signs of listening, and may have turned his head. If the bell were loud and sudden there was some startle response. Why, then, did not the conditioning go in the opposite direction? Why did not the dog substitute food for bell as well as bell for food? To make this question more reasonable, we will assume that bell and food stimuli are almost simultaneous.

The secret is that the food-salivation connection was the dominant one at the moment. The dog was hungry, so the connection had the support of a strong internal drive. The salivation was only one phase of a larger response—that of preparation for eating. Had the bell been loud enough or sudden enough to arouse a fear reaction, the bell-startle or the bell-escape connection might have been the dominant one and the conditioning might have been reversed. This can be easily demonstrated with an electric shock as the escape-provoking stimulus. Just as a hungry cat makes a lunge for an appetizing mouse we give it an electric shock. Only a few repetitions of this are necessary before we have a cat who avoids a mouse as if it were a thunderbolt instead of a prospective meal. Thus we see that the support of internal cravings makes some responses dominant at the moment and so determines in which way the conditioning will occur. Motives also probably determine whether or not conditioning will occur at all.

(2) *The Time Relations of the Two Stimuli.* Other things being equal, the new stimulus should be given first and the original one later. It is possible to obtain some conditioning if the order of stimuli is reversed. In Pavlov's experiment the order could have been food-bell rather than bell-food. But this order is not nearly so favorable. The dominance of the connection food-salivation probably saves the day in this case. In simple reflex responses like salivation or like the withdrawal of a paw or a finger from an electric shock, the best time interval is 0.2 to 0.6 seconds, with the new stimulus given first.[1] This interval may be lengthened to several minutes, however, and still obtain some conditioning. For example, with the Pavlov experiment, the bell could be rung,

then the food presented 2 minutes later with its immediate salivation. Eventually the dog learns to withhold his salivary response for 2 minutes after the bell is rung when it is given alone.

The order of stimuli, new-old, is a natural one. After conditioning, the response is to *follow* the new stimulus. One has to see to it that the new stimulus is there at least *before* the response is completed. Guthrie tells of a little girl who had the habit of entering the house, removing her wraps and throwing them about. Her mother had become desperate after a hundred remindings and scoldings. Upon a psychologist's advice she applied the principles of conditioning. She had the girl put on her wraps again, go out and re-enter the front door before removing and hanging them up. Very soon the sight of the front door led to the act of hanging up her wraps.

(3) *Repetition of the Stimuli.* Because Pavlov in his early experiments had to repeat the combination of new and old stimuli many times, even a hundred or more, it was thought that repeated exercise of the new connection was essential. It was soon found, however, by Watson and others, that sometimes a single trial was sufficient to produce a strong and permanent attachment of stimulus to response. In this connection we may cite Watson's method of conditioning fear reactions in a child. At the moment a rabbit was brought close to the infant a sudden loud sound brought on the natural fear and escape reaction. One trial was usually sufficient.

It is true that in most nonemotional reactions the greater the number of trials, the more likely is the new connection to function. Each motivated trial is known technically as a "reinforcement." Superficially, then, it seems that repetition strengthens new connections, upholding the old maxim, "Practice makes perfect." But, in reality, other factors are more important. As a practical measure we have to repeat the learning situation in order to guarantee lasting results in most cases. Yet it is possible to form new stimulus-response connections without repetition. Let us see why.

(4) *Distracting Stimuli.* If, at the moment we are applying old and new stimuli in combination, a third, irrelevant stimulus

breaks into the picture, the result is disastrous for the conditioning. There is interference with the normal course of events. Because living organisms are so complex and have so many avenues of stimulation open, distractions are bound to occur. Strict attention to the two stimuli of the conditioning situation is a help. Unless your experimental animal is attentive to your new stimuli, or is at least free from other competing stimuli, you may as well give up your efforts.

Pavlov very soon found that it was important to have soundproof, windowless rooms. He found that the more extraneous stimuli he eliminated, the smaller the number of trials needed to produce a conditioned response. Where formerly a hundred trials might have been needed, later only twenty might suffice. Still to be considered were stimuli from within the dog's own body. It is a fair assumption that if these also could be eliminated a single trial might suffice. A clear-cut learning of a stimulus-response sequence by conditioning, then, *depends upon an isolation of the stimuli and responses involved.* Repetition may merely serve to bring this about.

(5) *Emotional Reinforcement.* Conditioning that requires only a single trial is likely to have some emotional components. It was suggested before that probably no conditioning would take place without some internal support from motivation. The stronger the motivation, the more it reaches emotional proportions, the greater the alertness and vigilance of the organism. Also the greater is its singlemindedness. Interfering distractions are swamped out. If this reasoning is correct, there is little wonder that repetition is not essential for conditioning. Under strong emotions more direct and isolated connections between stimuli and responses can occur and leave their permanent effects.

(6) *Verbal Control of Conditioning.* Learning in the form of conditioning is found throughout the animal kingdom, even in the simplest species. In general the higher the species, the easier is the conditioning. It is an important form of learning in man. Among children, the normal ones are usually more easily conditioned than the dull ones. But Razran has shown that, beginning at about the age of four in children, the conditioning of the sali-

vary response is more and more uncertain.[2] In some individuals the learned connection is very easy to obtain. The new stimulus might be a ticking metronome, a spoken word, or a light signal. The old stimulus might be a pretzel or a lollypop. In other individuals no such conditioning takes place even after many trials. When once it is established in human subjects, it is forgotten much more slowly than in lower animals.

The reason for these facts is the greater complexity of human individuals and the greater chance of interfering factors. Most important of these factors is the mechanism of human speech. This enables human subjects to take on mental sets favorable or unfavorable to conditioning. This is why some resistance to simple conditioning begins to appear at the age of four when the use of the speech mechanism for self-control begins to exert its effect. Best results are obtained when the human subject does not realize that he is being conditioned or when he is hypnotized.[3] In the latter case he has temporarily given up self-control by his own speech mechanism.

Generalization of Stimuli. When a new conditioned response is being formed a striking phenomenon always occurs. The conditioned response will come not only to the new stimulus but also to other stimuli that resemble it. Pavlov's dogs, having learned to salivate in response to a touch stimulus on the flank, also salivated when touched at a neighboring point or even at distant points. Having learned to salivate at the sight of a circle, they also salivated at the sight of an ellipse. Watson's child, having learned to fear a rabbit, also feared a rat, a dog, a fur muff, and even whiskers. Older children, having learned to respond to a flash of light, also responded to the spoken word "light." The reverse transfer also took place; conditioned to the word "light" they responded to the visual light.

There are several ways of looking at this fact of generalization. One could assume, first, that the subject has failed to discriminate among the various stimuli which become effective. It is natural for the brain not to analyze or to discriminate before it is forced to do so for the sake of better adjustment. This we found to hold true for the process of sensory organization in general. Then, too, it must be remembered that every stimulus, as the brain reacts to it,

has several aspects; its shape, its size, its strength, or its location. Which aspect is the significant one to the organism is not certain in the early stages of conditioning. To be on the safe side, he reacts to any or all aspects of it. When those aspects appear in what to the experimenter is another stimulus, he reacts just the same.

Specialization of Stimuli. As the conditioning experiment proceeds, the range of similar stimuli that bring the response becomes narrower and narrower. Taught to respond to a circle, a dog at first reacts to many ellipses, even rather elongated ones. Later his reaction to the longer ones becomes more uncertain and is finally eliminated. Finally he discriminates even between a circle and an ellipse deviating only slightly from it. Or, another dog, taught to respond to a tone of 800 cycles, at first responds to tones all the way up to 1000 cycles. Later he comes to discriminate between tones of 800 and 825 cycles, responding to the one and not to the other. Incidentally, this fact has made the conditioned-response technique an almost indispensable one for testing the powers of discrimination of lower animals to small differences in stimulation.

The process of specialization is hastened very much if other similar stimuli are given occasionally *without* the old, effective stimulus. If we are trying to condition a dog to respond to a circle by salivating, we obtain the best specialization if ellipses are also presented *with no food,* whereas circles are presented *with food.* The dog is thus learning to withhold or inhibit his reaction to ellipses at the same time he is learning to release it following the sight of circles.

How Conditioned Responses Are Eliminated

Since conditioned responses are built into one's behavior it is only reasonable to believe that they can also be eliminated. Like most learned reactions, they can be lost eventually with the lapse of time. In other words, they can be forgotten.

Conditioned responses can also be more actively eliminated from the individual's repertoire of reactions. This is encouraging to those who may find themselves victims of conditioned fear reactions that are decidedly annoying if not actually disabling. For example, a certain child, frightened to the point of terror by a

locomotive on his first trip away from home, later became panic-stricken in going too far from home and lived for years within a limited space of a few blocks. A small girl, falling under a waterfall where she was caught, to be extricated only with help, for years suffered a terror of running water even in her own home. Some people cannot go near an elevator, some go into a panic on high places, some at the sight of blood or of a mouse, or even at the mention of them. Even though the person recognizes the absurdity of these fears and is very much restricted in his living by them, they may persist.

There are several ways in which such fears, and more minor ones too, can be treated. These treatments rest upon the principles of conditioning and of its elimination.

Extinction of Conditioned Responses. Any conditioned response wears itself out if it is not reinforced from time to time. After Pavlov's dog learned to respond to the bell alone, if the bell stimulus was repeated again and again always without the food following, it was not long until the response failed to follow. The dropping out of a conditioned response in this manner was called "extinction" by Pavlov. It is doubtful, however, whether the loss of the connection between stimulus and response in this manner is very complete or very permanent. Distracting stimuli coming at the crucial moment may bring back the response. After a lapse of time the response may spontaneously reappear. People with definite fears of certain objects know that no matter how many times they face the feared object they are still frightened by it, if the object stimulates them fully with its customary fear reaction. A still better method of elimination is a reconditioning or re-education.

Negative Adaptation. One method of reconditioning is known as negative adaptation. By this process the individual is taught not to react to a stimulus to which he previously responded. It requires us to apply the stimulus for the conditioned response, but to apply it so weakly or gradually *that the conditioned response fails to occur.* The stimulus became attached to the response in the first place because the two were maneuvered into the sequence of stimulus-response in the right time order. To eliminate the

connection we must now contrive to give the stimulus, seeing to it that the response fails to occur.

After a child has been conditioned to fear a rabbit, one should present the rabbit as a very weak stimulus, for example, at a great distance or in the form of a picture. Little or no fear results. Little by little the rabbit can be brought closer, always taking care to avoid any fear reaction. The child can be brought to handle it, finally, and the fear response is gone. The sooner the retraining process is begun, the better.

Examples of negative adaptation are many. The taming of a wild animal, the breaking of a horse to the saddle or to the harness, or the subjugation of a people to tyranny are illustrations on a grander scale. Good trainers of a saddle horse begin by simply placing a very light cloth on the horse's back. By increasing the weight of the cloth little by little, a saddle will be taken eventually without a violent response resulting, and finally a rider in the saddle. Getting used to new surroundings and to distractions are other very common illustrations of negative adaptation.

Substitution of Another Response. A still more positive step is to connect the stimulus to a new response. If an object arouses fear it can be made to arouse some other more desirable, emotional response instead. If a child fears a dog, let him catch sight of a dog at a distance while eating or romping or playing in a happy, confident frame of mind. Under similar circumstances, bring the dog nearer, little by little. One has to be careful in this case that the conditioning does not go in the reverse direction, giving the child a fear response to his meal or to his toys or other things present at the moment the dog arouses fear. The pleasurable response must be the dominant one at the moment, and it will soon become attached to its new stimulus. In line with this method, a child learns to like new foods if presented along with those he does like or followed by those he likes.

Elimination by Verbal Control. The fear of dogs can be lessened by giving the child information about dogs. Tell him stories about gentle and useful dogs. In a way this is merely the application of the principles of negative adaptation and reconditioning on the verbal level. Words, including the word "dog,"

are symbolic substitutes for things. Changing the child's attitudes toward the symbol "dog" serves to work toward a change of attitude toward perceived dogs. The training may or may not transfer readily to real dogs, but it will at least serve as a preliminary approach and it can be very effective.

The "talking cure" has been used to deal with many a morbid fear or *phobia*. In many cases the child or adult forgets the original, painful experiences that connected the object with fear. The incident may have happened before the child was old enough to talk and so he has never mentioned it. Or the incident was one involving feelings of shame or guilt, so the individual has avoided mention of the subject. In either case the connection between the stimulus and the fear reaction retains its unreasonable strength in spite of the normal attempts to eliminate it. The process of repression seems to isolate the connection and to keep it impervious to outside influences.

The girl with the phobia of running water is an example of this. When grown up she had forgotten all about the incident at the waterfall until one day her aunt reminded her that they had gone on a picnic and that the girl had disobeyed her by going wading. Not wanting the girl's mother to know about the negligence of the aunt or of the disobedience of the girl, they dried her clothing and swore themselves to secrecy. Recalling the incident to consciousness, that is, by verbalizing it, seeing its humorous side, confessing the childish guilt, and reacting to the whole thing as an adult should, all these things decidedly lessened the fear. Apparently no reconditioning could occur until enough of the entire circumstances could be reinstated in verbal terms.

The Significance of Conditioning

We now raise the question as to just how important conditioning is as a form of learning and we will try to see exactly what takes place when a conditioned response is learned. There are some psychologists who claim that it is the basis of all learning; that there is no learning without conditioning. Others regard it merely as one of several varieties of learning. Not all agree as to exactly what takes place in conditioning.

The Law of Association. Two thousand years ago Aristotle, in speaking of human memory, said that we recall together ideas that we experienced together. Experiencing two things side by side or in succession tends to produce a connection between them. Even the average person, untutored in psychology, realizes that he forms associations between things so that when he meets one of them he is likely to think of the other. The condition favoring the connection is *contiguity,* which was mentioned as a strong determining factor for sensory organization. Why cannot we interpret the conditioned response on the same basis? Why cannot we say that the dog has formed an association between food and bell, organizing them into a new unit?

Were we in the dog's place, something like that would happen. A situation similar for us is when we hear the dinner gong in our home or at a boarding house. The dinner gong has been followed by the sight of food and by eating, time after time. The gong, after a few repetitions, makes your mouth water, but it also makes you think of food and you may have images of steaks, ice cream, and pie. Can we say that the dog, also, has images of food and other ideas and that these ideas are substitute stimuli for real food? Unfortunately, the dog cannot introspect for us. Note that in our own case the mouth waters, usually without our even realizing it, and certainly this salivary response was learned unconsciously by us. It would undoubtedly come without our imagining or thinking of food. It could also come thus in the dog, without any intermediate ideas.

We need not, therefore, assume any association of *ideas* as a part of the conditioning process. The only association we can be sure of is that formed between a sensory stimulus and a glandular response. This is one reason why Pavlov's first discovery of the conditioned response was so revolutionary in psychology. It offered a principle for understanding learning observed objectively in other individuals. Associations between stimuli and responses replaced the talk about associations of ideas. And the mere substitution of one stimulus for another as the conditioning formula seemed to offer a very simple key to all development by learning.

An Evaluation of Conditioning. We cannot yet say that all cases of learning can be reduced to conditioning. At present it is

best to regard conditioning as merely one variety of learning, though an important one. Other varieties of learning will be brought out in the next two chapters. All types of learning undoubtedly obey the same fundamental principles, the conditioned response included. These principles have to do with the formation of organized patterns; patterns of stimulation (sensory organization), of response, and patterns of connection between stimulation and response. We have treated the conditioned response as if it were primarily a new connection between stimulus and response. This simple formula may need serious revision, but it will serve our present purpose. For example, it is known that a response after conditioning is not exactly the same as before. Thus, the simple substitution formula needs modification.

Importance in Human Behavior. In human behavior the typical conditioned responses are usually involuntary or reflexive in character. Emotional responses are the best examples. One's likes and dislikes, interests and attitudes are also often conditioned. This part of our training alone is of the utmost importance for the development of personality and character. The internal bodily organs, in addition to the role they play in emotional behavior, can be conditioned to respond to outside stimuli. The contraction or relaxation of the fine muscles controlling the arteries can be conditioned to the sound of a buzzer or of a bell.[4] Sleep can be brought on as a conditioned response to certain stimuli. Digestive processes can be conditioned to respond normally or abnormally to outside stimuli. In rabbits, the production of antibodies against cholera has been conditioned as a response to tactual or thermal stimuli applied to the rabbit's ear.[5] These few examples are only suggestive of the great possibilities that may lie before the medical man who is willing to pay some attention to the facts of conditioning, its power to cause physiological disorders, and its possible use in treatment.

Summary

Learning is defined as any change in behavior resulting from previous behavior. Remembering that behavior is conceived as a matter of stimulus followed by response, we can think of three

places at which learning can take place. Roughly, learning involves changes either on the sensory side of the stimulus-response pattern, on the motor side, or in the connection between the two.

In the conditioned response we have a new connection formed where little or no connection existed before, between a certain stimulus pattern and a certain response pattern. The response had been previously aroused by another stimulus. If old and new stimuli are applied together repeatedly, the new stimulus finally becomes effective. In conditioning, we have what seems roughly to be the substitution of one stimulus for another.

A great many factors serve to facilitate the formation of a conditioned response, while still other factors tend to interfere with its formation. In a newly-formed conditioning there is a generalization, so that stimuli similar to the new one are also effective for a time. With further conditioning there is specialization, so that the new stimulus is more sharply discriminated from others.

Conditioned responses may be eliminated from an individual in various ways. Some form of reconditioning is most effective in removing a conditioned response.

All conditioning probably falls under a more general principle of learning, the formation of associations between stimuli and responses, in other words, the organization of stimulus-response patterns.

Questions

1. Collect and describe briefly some examples of conditioned responses you or others have observed.

2. Find in other textbooks or other sources, some additional interpretations of the conditioned response, aside from the substitute-stimulus formula given in this chapter. Which one seems most reasonable? Why?

3. What role can you see for generalization of stimuli in the formation of personality traits such as shyness, honesty, or neatness?

4. In the process of specialization, for example when a dog is being trained to salivate in response to a circle but not to an ellipse, when the difference between the stimuli is made so small that his powers of discrimination fail, the animal frequently suffers a breakdown, salivating at random to many kinds of stimuli, and showing general nervousness. Explain.

5. Hunting dogs that are being trained to bring birds to their masters without crushing them in their jaws are often first given birds full of sharpened sticks to carry in their mouths. Explain the conditioning principles involved.

6. Show how most of the methods of eliminating conditioned responses can really be classified as cases of reconditioning, or new substitutions.

7. Point out a similarity between conditioning new responses and acquiring new meanings as discussed in Chapter XIII.

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CHAPTER XV

Other Ways of Learning

THE Discovery of Trial and Error. The story is told of the great naturalist, Lloyd Morgan, who one day made a profound observation upon learning in one of his pet dogs. This dog had previously learned the habit of running to fetch a stick or cane that was playfully thrown. One day, on his morning walk with the dog, Lloyd Morgan threw a stick over a fence. There was a hole in the fence just large enough for the dog to crawl through. He darted through the hole, grasped the stick in his mouth in the usual manner, bounded back to return through the hole, and was brought to a sudden halt. The stick, held crosswise in his mouth, was too long for the hole.[1]

Not having the ability to see the cause of his failure, the dog persisted, trying, again and again, to force his way, stick and all, through the hole. Again and again he dropped the stick. Again and again he picked it up. Finally, as if by accident, he picked up the stick at one end. Trying the hole once more, he got through. Had he learned anything? The only test was to try him again with the same situation. If he grasped the stick in his mouth by one end, when he tried to get through the hole, he had learned something. If he held it crossways, in his usual manner, it would seem he had not.

The experiment was immediately repeated. The dog seemed to have profited nothing by his previous experience. He proceeded

in nearly the same fumbling, stupid manner. Again, he finally succeeded, as if by chance. But in this trial it took less time and not so many false starts as in the previous experiment. This reduction in time and in number of errors might have been an accident. But it probably was not, for on the days following, there was further reduction in time and errors, until one day the dog did the right thing immediately. Even then, however, there was no indication that the dog knew why he failed when he did, or why he succeeded when he did. In some blind, yet certain fashion, his wrong responses to the situation were all finally avoided, and only the right responses prevailed.

Some Typical Experiments on Trial and Error

It was not long until Lloyd Morgan's little experiment was duplicated in the laboratory in many ways, teaching us much about learning in general. Most of these experiments have had to do with lower animals, but this does not mean that human beings do not indulge in trial-and-error behavior. They do. Because lower animals are so much simpler than ourselves and because the very same laws of learning that apply to them also apply to us, they have been favored subjects in these experiments.

Requirements for an Experiment on Learning. In all learning experiments one must first motivate his subject. Lloyd Morgan's dog struggled to get the stick back to his master, who would reward him perhaps with an appreciative pat on the head, a sound of approval, or a morsel of food. Whether or not we can say that there is never any learning without motivation is a question. Certainly, one has to apply stimuli to his subject, and stimuli are not effective in making the subject do anything unless they connect somehow with a motive. A second requirement for our learning experiment is to place some obstacle in the path of the subject so that, to reach his goal, he must do something new. We may place a series of barriers in his path, or we may give him a complicated obstacle that requires the formation of a new pattern of movements on his part to master it.

Thorndike's Puzzle Box. In Thorndike's early, classical experiment, his subject was an ordinary house cat. The motive was

hunger. The hungry cat was placed inside a cage with an appetizing fish outside. The door could be opened by pressing down upon a small lever inside the cage. How soon would the cat learn to use this mechanism? How would she be able to master the problem?

The cat, stimulated from within by hunger pangs, and stimulated from without by the sight of the fish, made her customary

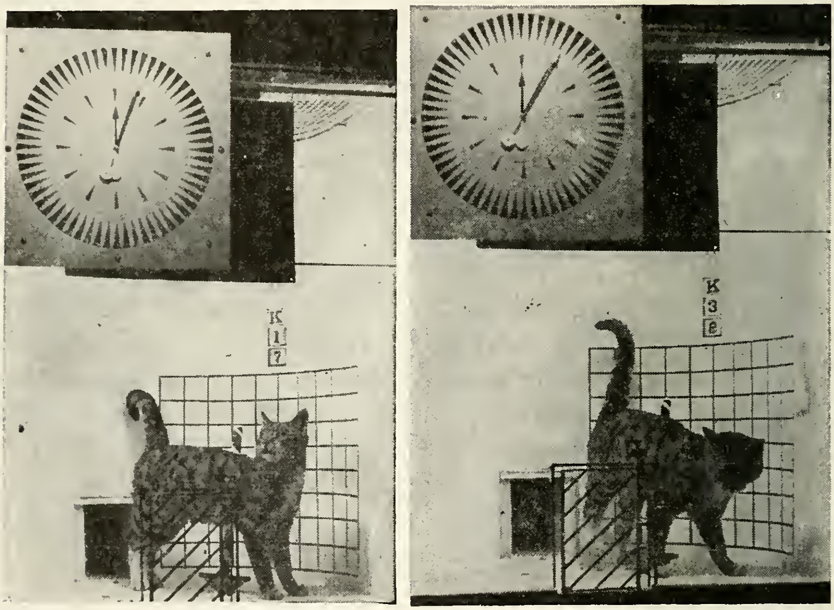

FIGURE 15.1. A problem situation which a cat typically solves by trial-and-error behavior. The cat is let into the enclosure from a door in the rear. He makes an effort to get out of the enclosure. An additional incentive is a bit of canned salmon outside the enclosure. The door in front is released and opens when the cat rubs against the post. The clock dial shows the elapsed time from the cat's entrance into the enclosure to its successful movement of the post. (Courtesy of E. R. Guthrie and G. P. Horton.)

efforts to reduce the distance between the fish and her stomach. She had met obstacles and barriers before, and had acquired certain methods of dealing with them. The perceived situation elicited a variety of movements; reaching through the bars, gnawing at the bars, clawing, pushing, shoving, running back and forth, and so on. Her movements might have appeared random to the observer who did not know her past history. They were undoubt-

edly guided or "forced" by the appearance of the situation and by what she had learned to do in the past.

Finally, if she had not become exhausted, one of her movements tripped the trigger, the door opened and she ate her fish. On the next day, like Lloyd Morgan's dog, she showed little or no external signs of having learned a thing. But the time consumed in making wrong movements was shorter than on the day before. Within a few days she had mastered the problem. The moment she was put in the cage, she stepped on the trigger and made no more "random" movements. The trigger had now become the "key" to her problem. How had this been accomplished?

The Discrimination Problem. The following experiment, a popular one for studying the powers of sensory discrimination, in animals, is much better controlled. In Thorndike's puzzle box the cat had a choice of one correct response versus a large number of incorrect ones. In this experiment there are only two main alternatives: a right one, and a wrong one.

A typical apparatus for the experiment is shown in Fig. 15.2. The problem is to teach the animal, usually a white rat, to run to the lighted alley in preference to the dark one in order to get food. As an additional incentive, there may be an electric shock waiting for him when he enters the wrong alley. The position of the light is changed from left to right in haphazard order between trials. Otherwise the rat would very easily learn to choose the right alley by its position, which is a very easy problem for him. It is much harder for him to learn to react positively to the light, no matter which side it is on, and negatively to the dark side. Our concern is to explain how the rat learns to respond as he does to one of two signals. To put the question more fairly, we ought also to ask how he learns to avoid the other signal.

Maze Learning. By far the most popular kind of learning experiment has been that with mazes. Fig. 15.3 shows one type of maze. A maze is essentially a series of alleys, some leading to the goal and others leading into cul-de-sacs or dead ends. From the starting place to the goal, the subject meets a number of points where he must choose one of two alternatives. For rats, the partitions are built in the form of walls over which they cannot climb

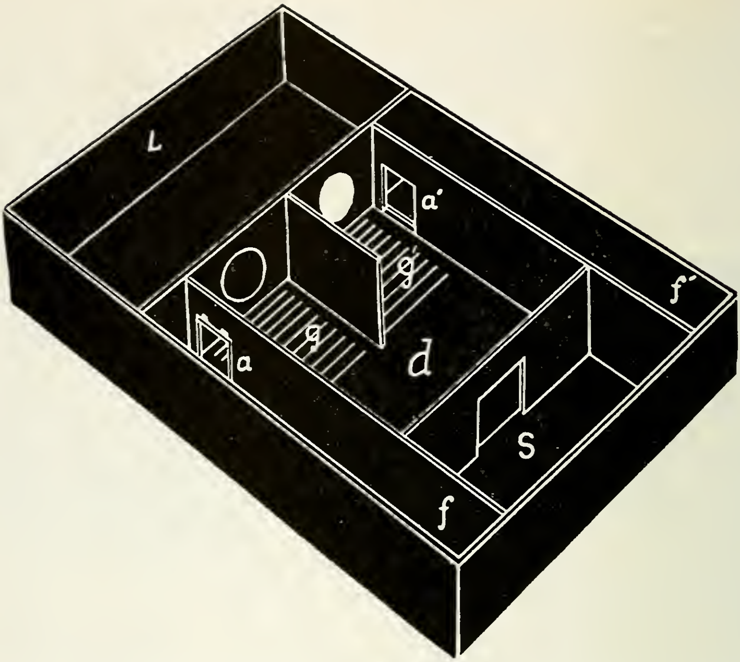

FIGURE 15.2. Apparatus used in the brightness-discrimination learning experiment. The animal starts at *S*, must make his discrimination at *d*, pass over an electric grill, *g* or *g'*, one of which gives an electric shock, through door *a* or *a'*, reaching food at *f* or *f'*.

FIGURE 15.3. A common type of maze used for learning experiments in the psychological laboratory.

For human subjects, the maze pattern may be in the form of grooves or slots in fiber board, in which a pencil or stylus is moved. It may be in the form of ridges raised on the surface of a board to be followed by the finger tip. Or it may be a printed form. In order to make the human problem more comparable with that of the rat, the subject may be blindfolded in using the slot maze or the finger maze, or he may be given a small peephole exposing only a small portion of the maze pattern, which he traces with a pencil, when using the paper form. The maze patterns can be

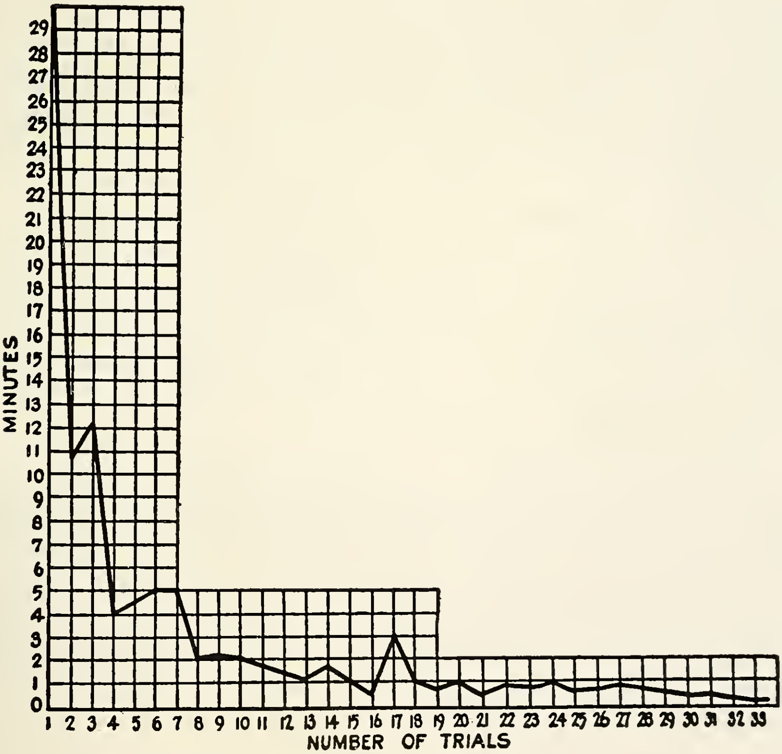

FIGURE 15.4. A typical learning curve for the rat in the maze when the score is in terms of the time required to run the maze at each trial. (After J. B. Watson, courtesy of the *Journal of Comparative Psychology*.)

made identical for both rat and man, and their modes of learning can then be compared in this manner.

Learning Curves. The rate of learning a maze may be shown graphically by means of a learning curve, such as the one in Fig.

15.4. The success of the subject in each trial, or rather, the lack of success, can be indicated by the time required to go from the starting point to the goal, or by the number of errors. An error is tallied against the subject when he enters a blind alley, and also when he retraces the correct path backward toward the starting point. In either case, the curve is a descending one; the shorter the time, and the smaller the number of errors, the more the subject has learned.

The decrease in both time and errors is typically very rapid during the first few trials, and then slower, as the subject approaches his maximum speed and his errorless performance. The error curve can drop to zero eventually, but the time curve obviously cannot. Similar learning curves can be drawn for data from the puzzle-box type of learning problem and from the dscrimination problem.

How Trial-and-Error Behavior Results in Learning

As yet, we have not explained how or why a subject learns at all in the hit-and-miss fashion just described. Why do wrong movements drop out of his behavior and right movements remain, in response to the situation? There have been many answers suggested to this question. We will consider only two or three of the more reasonable ones.

The Frequency Theory. A very old conception of habits and how they are formed is expressed in the trite saying, "Practice makes perfect." To master a habit, repeat it over and over again. This was supposed to stamp into the brain the necessary changes for performing the habit quickly, smoothly, and efficiently, as if each repetition merely deepened some impression in the brain. This idea was carried over to the explanation of learning by trial and error.

The Factor of Frequency. Let us take the simple discrimination problem first. Assume that in the very first trial the rat is equally inclined to go to either the lighted or the dark alley. If, by chance, he goes to the wrong side, he must withdraw and eventually go to the correct side. If, on the other hand, he goes immediately to the correct side, the trial is over with. On every trial, therefore, he is forced to go to the correct side. But in some

trials he does not go to the wrong side at all. This circumstance forces him to go to the right side more times than to the wrong one, so the theory goes, and therefore he is exercising the connection between the situation that stimulates him, and the act of running to the light, more frequently than he is exercising the connection between the situation and running to the dark alley. The more he exercises the correct association or connection, the stronger it becomes, at the expense of the wrong one. In the end, the correct response prevails.

Frequency Alone Does Not Work. There is only one thing wrong with this particular theory. It does not always agree with the facts. One fact against it is that the subject may actually exercise the wrong connection more times than the right one, and still learn. Suppose that there is no punishment in the wrong alley. The rat may enter it, retreat from it, but turn around and re-enter it a number of times. This behavior has actually been observed. The subject on any trial enters the correct alley only once, because that ends the trial. But he may re-enter the wrong alley a number of times. If the exercise of a connection between stimulus and response is equally effective every time, the rat should learn the wrong thing, in this case, instead of the right thing.

Negative Practice. Dunlap has demonstrated the fact that one can actually learn to do the right thing by practicing the wrong thing. In his own habits of typing, he was annoyed with the error of writing "hte" for "the." As an experiment, he decided not to sit down and practice "the" as one would ordinarily do. He practiced, instead, his error, "hte," hundreds of times. His error disappeared from his regular typing. Others have tested this method a number of times with like success. Dunlap called the method, "negative practice." The point for us, here, is that repetition, as such, may unlearn something as well as learn it. Before deciding to apply the method of negative practice, wholesale, however, we must know why repetition sometimes gives positive results and sometimes negative; why it sometimes seems to "stamp in" as the common opinion holds, and why, at other times, it "stamps out."

Thorndike's Law of Effect. Thorndike accepted the idea of exercise of an association between stimulus and response by repeti-

tion, but he realized that the factor of frequency of exercise, alone, would not explain learning. He was impressed with the apparent weakening effect that occurs in wrong responses as well as the strengthening effect of correct responses. He concluded that there must be something about the success of correct responses that increases the strength of a connection, and something else about the failure of a wrong response that tends to weaken it.

Satisfaction and Annoyance. At first he believed the pleasure or satisfaction accompanying successful responses was responsible for strengthening the connection just exercised. He believed the displeasure, or pain, or annoyance following failure was the significant factor for weakening the connection just exercised. Later, not wishing to imply that the lower animals experience anything like what we call pleasure or satisfaction, he spoke of a satisfying state of affairs as a key to learning, defining it as "one which the animal does nothing to avoid, often doing such things as to attain and preserve it." An annoying state of affairs, another key to learning, he defined as "one which the animal avoids or changes." * Thorndike's famous "law of effect" may be stated as follows: Exercise of a connection that leads to a satisfying state of affairs strengthens that connection, while exercise of a connection that leads to an annoying state of affairs weakens that connection.

Effect and Negative Practice. The law of effect accounts nicely for Dunlap's method of unlearning by repetition. When typing "hte" he knew it was wrong and was annoyed at his continued error every time he repeated it. The essential thing to make his method work in breaking habits in general is to make sure that the practice is really annoying. The habit of thumbsucking has been successfully treated in this way. A child old enough to have any feeling about his own appearance or behavior is forced to stand sucking his thumb while looking at himself in the mirror ten minutes every day. His feeling of shame or chagrin is absolutely essential. Other persistent habits may be cured in a similar manner. But if more positive methods are possible, they should be used, instead. The method of negative practice should not be tried for breaking

* E. L. Thorndike, *The Fundamentals of Learning.* New York: Bureau of Publications, Teachers College, Columbia University, 1932, p. 176.

a habit except under the advice and guidance of a competent psychologist who knows the background of the person with the habit.

Reward and Punishment. Thorndike's theory calls to mind the common use of rewards and punishments in the attempts to teach other individuals. It is common sense to reward desired behavior and to punish undesired behavior. We hope in this way to see that the desired actions are repeated and that the undesired actions are avoided in the future. Roughly, this is what happens, although we are forced to recognize that there are many apparent exceptions. It would be surprising to find that a teaching device that has worked so well for centuries did not have some fundamental, psychological principle underlying it. Common sense has never bothered to explain why rewards and punishments are successful. Hence, it has failed to get at the underlying principles. It has rarely tried to find out just when and how much reward or punishment should be applied in order to obtain the best results. After much patient and exacting work scientists have discovered some of the underlying principles, though their work is not complete. A few principles of practical importance will be mentioned briefly.

(1) *A reward must satisfy.* This principle might seem too obvious to mention, but it is often violated in practice. A real reward is something that fulfills a need or craving at the moment. Food is no reward to a satiated individual. A rat that has had sunflower seed at the end of the maze a number of times, loses zest for learning after finding a substitute there. In school life, what may seem to be a reward to the teacher may be merely a disappointment to the pupil, and what she regards as punishment may actually be a reward.

(2) *The greater the reward the greater the effect on learning.* Thorndike found that with rewards of .1, .2, .4, and .8 cents for every successful association given between English and Spanish words, in general the greater the reward the faster the learning of children.[2] But with a reward of .8 cents, there was a slight lapse because of the excitement aroused by it. When the amount of food reward was increased six times, chicks learned 25 per cent

faster. The sight of food alone as a reward, was very ineffective in fostering learning.[3]

(3) *The maximal effects of reward or punishment occur when they follow the response immediately.* To have any effect at all, reward or punishment must be associated with the act. The nearer they come in time to the act the greater the possibility of an association, due to the law of contiguity. With rats, in the discrimination problem, delays of the reward from 5 seconds to 20 minutes were introduced.[4] There was a rapid falling off in rate of learning up to one minute, and a slower loss thereafter, until approaching 20 minutes no further loss was found. Similar results have been found with chicks in the same learning problem. Male rats, given an electric shock at the moment of mating with a female, and at different short time intervals following, learned to delay mating on later occasions. The effect of the shock was maximal when given with no delay, it decreased rapidly to a delay of 5 seconds, and was completely ineffective after 7 seconds.[5] The length of time that can occur between the response, and either reward or punishment, and still leave them effective, will naturally vary with the subject's ability to associate the two, and will also depend upon what happens during that time interval.

(4) *Rewards are generally more effective than punishment.* Slight punishments are likely to be merely interesting or exciting, and so have an effect opposite to that intended. They gratify the desires for attention and for novelty. On the other hand, when punishments are very severe, they have paralyzing and disorganizing effects, and they lead to a negative attitude toward the one who administers them. Rewards condition the individual favorably toward the one who administers them, and so lead to future cooperation and obedience. The management of children in home and in school, the management of traffic problems, and of criminals, too often violate this principle.

(5) *Punishment is of little value unless it leads almost immediately to a change of response.* The chief virtue of punishment is that it forces the organism to withdraw from the thing he is doing and to try something else. Mere punishment followed by

inactivity is apparently of little or no avail. A golfer who has just sliced the ball suffers as he sees its wild flight. To receive the full benefit from this mistake, he should hit another ball immediately, trying to correct his stroke. Thorndike had subjects throw balls over their heads at a target which they could not see. They were told of their errors after 1, 2, 4, and 6 seconds, and, sometimes, not until after throwing the next ball. There was less improvement when the subject had to wait even 4 and 6 seconds to be told of his success or failure, and none at all for the delay until after the next throw.[6]

Punishment is useful mainly for what it forces a person to do. Punishment for the sake of "getting even" is worse than valueless for the criminal. Much punishment of criminals has an effect opposite to the effect for which the punishment was designed

(6) *Punishment is most effective when applied at the initiation of a response.* A rat enters a blind alley after seeing its entrance. Not until he reaches its dead end is he caused to retreat. How much more effectively would the error be impressed upon him if he had received a slight shock at the moment of entering! Then the association of the punishment and the sight of the entrance would be made more certain for him. Such an arrangement better satisfies the formula for conditioning of responses. Much of the learning produced in trial and error appears to be conditioning, although not all. How much more effective would the punishment of the criminal be, if pain could be inflicted the moment he entered the bank he intended to rob, or the moment he raised his arm to shoot the policeman, and if this could be repeated until conditioning were firmly established!

(7) *Exceptions weaken seriously the effects of reward and punishment.* It was shown in connection with the conditioned response, that the key to the formation of an association is the isolation of stimulus and response. Out of the welter of stimuli and their responses going on at the moment in which old and new stimuli are given together, the subject must isolate the connection that is the most constant. Repetition is an aid in this. One new stimulus, out of all others, is sure to be present every time: others are present or absent in irregular order. That is why the response

becomes conditioned to the one stimulus and not to the others. Thus, if reward and punishment are present only spasmodically with a response, there is no guarantee of a desired connection being formed. The application of this principle to modern criminality is obvious. The uncertainty of capture, the uncertainty of conviction, the uncertainty of the extreme penalty, the probability of parole, all encourage the criminal to "take a chance."

Perception in Trial and Error. So far, little has been said about the role of the senses and of sensory organization in learning. We can no longer ignore this factor. By this time it is rather trite to say that what an organism does in a situation will depend upon how he organizes it for himself. It is reasonable to believe that what pattern of movements the animal uses at the moment will depend upon what his sensory organization is at that time. To the experimenter, the puzzle box may remain a stable, perceived object with very familiar properties, because he invented it or has examined its construction. This is no sign that the cat inside, trying to get out, and prevented from learning anything about the mechanism beforehand, perceives it in the same manner. Like any new and strange object, the box probably undergoes a number of transformations for the cat in his observation of it.

Sensory Learning in the Puzzle Box. As the cat finally masters the mechanism that opens the door, it takes on new significance for him. The pedal may stand out for him as a figure on a ground. It catches his attention the moment he is placed in the box for a new trial. It has a meaning as, "that thing to be pulled," though of course the cat, unlike man, cannot verbalize his meaning. He merely demonstrates his meaning by reacting adaptively to the pedal. His reaction to it is not like a typical conditioned response, for his movements in depressing the pedal vary from time to time. Sometimes he presses it with one foot, sometimes with another. He may press it with his chin, or he may sit on it. He may get the same result by grasping the pedal or the rope with his teeth. The natural thing, however, is to develop some stereotyped pattern of movements that looks rather mechanical. But even this may be deserted for a variation when necessary or convenient.

Sensory Learning in the Maze. And what of the rat in the maze? Does he show any signs of having made observations, or of having developed any conception of the maze pattern? Or is he guided by one stimulus at a time as he comes to it? Several facts indicate that he develops some vague notion of the maze as a pattern. Observing experimenters have found that a rat is about three times as likely to enter blind alleys that point in the direction of the goal as he is to enter alleys pointing away from it.[7] If he is offered a number of alternative, correct pathways, all open, he can follow any one of them, and may vary his route from time to time after learning one of them.[8] If, after learning a maze with blind alleys, one or more of the walls are removed, offering short-cuts in the rat's way to the goal, he is likely to take the short-cuts.[9] His running of the maze after learning is not merely a chain of reactions, each one completed setting off the next in line; for, having learned to run through a maze, he can swim through it or roll through it.[10] It is doubtful whether he has a visual image of the layout of the maze. But he does seem to have a spatial orientation that includes an awareness of the general direction of the goal, and perhaps some awareness of relations between alleys.

Insight

Credit for perceiving what is the significant element in his puzzle-box situation is probably all the credit the cat deserves for awareness of his problem. After complete mastery of it, he still does not know why his method works. The mechanism is entirely beyond his powers of observation and comprehension. In contrast with the cat, a boy of six or seven years could look over the mechanism and immediately press the right element to open the door. This is true, provided he be given an advantage that the cat did not have, namely, to see the outside of the cage. What does the boy have that the cat does not have? Could a mechanism be made simple enough for the cat to grasp its organization, as the boy does the more complex one? We know that the boy has his own limits of observation. We could easily make a complicated mechanism that he could not grasp by observation alone.

Köhler's Experiments on Insight. Köhler suspected that Thorndike's cats had to resort to their rather hit-and-miss behavior because their situation was entirely too complex for observation. He designed some simpler problems for use with different kinds of experimental animals: dogs, hens, monkeys, and chimpanzees. Fig. 15.5 shows one of the simpler problems and the difference in behavior exhibited in it by hens and by dogs. Food is placed outside a picket fence that extends between a house and a rather short wall. The hungry animal is introduced between the house and the wall. Notice what the typical hen does. The lines show what kind of path she takes. At first, there is much running back and forth near the fence beyond which the

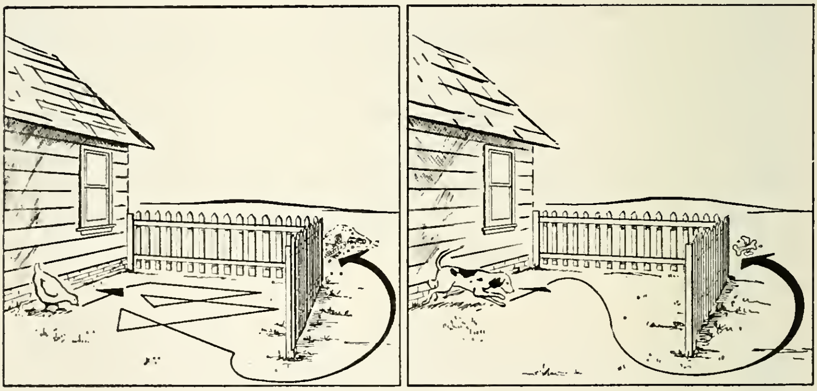

FIGURE 15.5. Diagram contrasting behavior with and without insight.

food lies. She does not see that all she must do is to make a detour around the short wall. If the wall is made short enough, some time, in her darting back and forth, the hen will be in a favorable position for seeing the solution of her problem. When she does, there is a decided change in her behavior. She sweeps immediately around the wall and reaches her goal. The dog, when placed in the same situation, is more likely not to show trial-and-error behavior, but to trot around the wall immediately, as do monkeys and young children.

In the case of the dog, monkey, and child, we cannot be sure that they have not mastered the reaction of going around obstacles before, although such previous experience may not be necessary

as a prelude to their success in this problem. It is quite possible, too, that the hen had had previous experiences in going around obstacles. We see from the diagram the general events leading up to the hen's mastery of the problem. We can see where in her pathway she apparently became aware of a solution that worked. This type of solution Köhler called "insight." What the hen did, after this moment of insight, that she could not do before was to see an organized perceptual pattern, with the short wall in a new relation to the food. Before insight, it was merely an insurmountable obstacle; afterward, it was something to go around. There is a change in meaning and significance, as well as in sensory organization. Insight, then, is a matter of observing new relationships, of creating a new sensory organization or meaningful pattern.

Insight in Apes. Other experiments of Köhler show when apes are able to attain insight and when they are not. The amount of insight depends upon the age, intelligence, and the past experiences of the individual. One simple task most apes could learn was to use a short stick with which to reach outside the cage and rake in food and other desired objects. Food tied to the end of a string could very easily be pulled into the cage. By crossing and crisscrossing this string with others like it, the perceptual problem was made more difficult, but the simpler puzzles could be mastered. The apes learned almost as easily to use a long pole to knock down fruit hanging in the top of the cage beyond reach. Having learned to stand a pole on end, run cat-like up the pole, and then jump, as a kind of game, they used this stunt, later, to reach a handful of fruit hanging above their heads.

Learning to reach fruit overhead by fetching a box to stand on was not so easy. Much trial and error entered into this before insight came, and then the box had to be somewhere near the fruit before the solution came of setting it beneath the fruit. Having used one box, the apes learned to stack one or more on top of the first one to reach higher morsels of fruit.

The prize example of learning by insight, however, was the task of splicing two short sticks together to make a long one. Only the most intelligent of the apes in Köhler's colony could master this one. Given two short bamboo sticks, each too short by itself to

reach the fruit outside the cage, Sultan was "stumped" at first. One stick was smaller than the other, and could be fitted inside the hollow end of the larger one to make one long stick. Sultan indulged in much trial and error, and, after an hour or so, seemed to give up. While simply playing with the sticks, he happened finally to place them end to end. The moment of insight came. He shoved the smaller one into the hole of the larger one, went to the fence, and raked in his banana. The sticks fell apart. He placed them together again. Showing little interest in the bananas, he proceeded rather to rake in sticks and straws and other objects, deriving apparent satisfaction, as one would from a new invention. On the next day he needed only a short time to get the splice made. This is characteristic of learning by insight. Once correct insight has occurred, there is little or no further error. The problem is mastered once and for all, except for normal forgetting of insights, which, like anything learned, may be forgotten in time.

Insight in Young Children. Many of Köhler's experiments with apes have been duplicated by Alpert with children between the ages of two and four. Nine situations were provided whereby the child had to learn to reach the toy he desired by means of boxes, chairs, sticks, and poles. In over half the cases, insight was gained in a very few trials. Given one trial a day, most solutions came, if they came at all, within the first two days. Insight usually came suddenly, but it was not always complete, and it was not always correct. Partial insights do occur, but in these problems, they were more frequent in Köhler's apes than in Alpert's children. Wrong insights are usually tested immediately in what may look to the outsider like trial and error.

Insight in Adults. Some classical experiments of Ruger show the differences between trial-and-error solutions and insightful solutions, and also how trial and error and insight occur together in human adults. Given a new mechanical puzzle that looks complicated, the average, intelligent person will first stop to look it over, trying to see whether any familiar principle may apply, or whether he can see any significant relationships. As he looks it over he also turns it about in different positions. Doing this usually brings the parts into positions more favorable for insight.

Failing to gain any idea of the puzzle's plan, he may next resort to pushing and pulling in a more random manner, twisting and turning, and forcing it a little here and there. He may finally become emotionally excited and his trials more random and blind, making up in energy what they lack in guidance and precision.

An important lesson to be learned from this example is that insight depends upon our powers of sensory organization. When the problem promises to be simple enough, we solve it by observation, or try to. When it is beyond our powers of organization, or when we think it is, we lapse into the more primitive trial-and-error type of behavior. The point at which this lapse takes place will depend upon the urgency of the problem and upon its apparent difficulty. It is said that in times of stress and uncertainty, such as an economic depression, bankers and businessmen of high intelligence and positions may hie themselves to astrologers and soothsayers, seeking advice. They are willing to try anything in the chance that something may work.

Another conclusion to be gained from this experiment is that trial and error and insight go hand in hand. As with the ape, the incidental manipulation of the object may bring it into positions where insight is made possible. An insight is often incorrect. Althought it be incorrect, it frequently prompts the next move. Another element that enters into human problem solving is the ability to try out an insight without going through the actual motions. This is a symbolic or thinking type of activity, which is even more rare than insight in the lower animals. Trial and error thus may proceed at this high level of symbolic activity, in which case the process of thinking occurs.

Acquiring Human Skill

The kind of activity in which human individuals are most likely to resort to trial and error is that of acquiring skilled patterns of movement. Here the emphasis is on the formation of patterns of muscular movement. No one can know beforehand just what combination of muscular contractions will be needed in performing an act such as the pole vault or walking the tight wire. All the individual can perceive is the goal he wants to

attain, and whether or not his act came near that goal, and sometimes what kind of an error he made.

Perfect Skill Is Rarely or Never Reached. Some individuals are content when they master only a rough pattern that attains some goal for them. They do not strive for perfect form such as we find in expert typists, in Olympic stars, in a Paderewski, a Lily Pons, or a Fred Astaire. Some are content with the minimum essential, of holding a job where competition may be nil, of playing a bad game of golf, or of playing at a hobby not taken seriously. Practice, again, does not necessarily make perfect. When greater inducements are offered, there is likely an increase in efficiency. A group of typesetters of ten years' experience were once chosen as subjects in an experiment concerning the effects of alcohol on mental work, because it was assumed that, by long practice, they had reached the peak of efficiency. To the surprise of the experimenter, in two weeks' time they had gained tremendously in their performance because they were under observation of the experimenter, and also, perhaps, because of some element of rivalry. Rarely does an individual fully extend himself in his work.

Learning Curves for Acquiring Skill. One's efficiency can usually be measured at any stage of his practice in a new task. In a task like typing, for example, the number of strokes per minute would be a good measure of performance. If practice periods are kept regularly, and if effort is maintained at a constant level, it is possible to study the rate of learning at different times. This can be shown graphically by plotting the measure of performance against the amount of time devoted to practice. Fig. 15.6 shows two learning curves for an individual who was learning telegraphy. One curve shows the rate of improvement in speed of sending messages, and the other the rate of improvement for receiving messages. The measure of performance is in terms of the number of letters per minute, and the practice time is given in terms of weeks, the same number of minutes per week being devoted to practice.

The Physiological Limit. Notice that the learning curve for sending rises more rapidly at first, showing an apparently quick early gain, and then it rises more slowly, until near the end of

40 weeks, where there is almost no more gain. We should expect the curve to level off at some upper limit, for beyond such a limit of speed the individual cannot go, no matter how much he tries. This limit is imposed by the speed of his nerves and muscles, and so we call it the *physiological limit*. There is a physiological limit for any motor performance. Every learning curve for a motor task levels off approaching this limit, if practice is continued long enough and seriously enough. Different individuals, naturally,

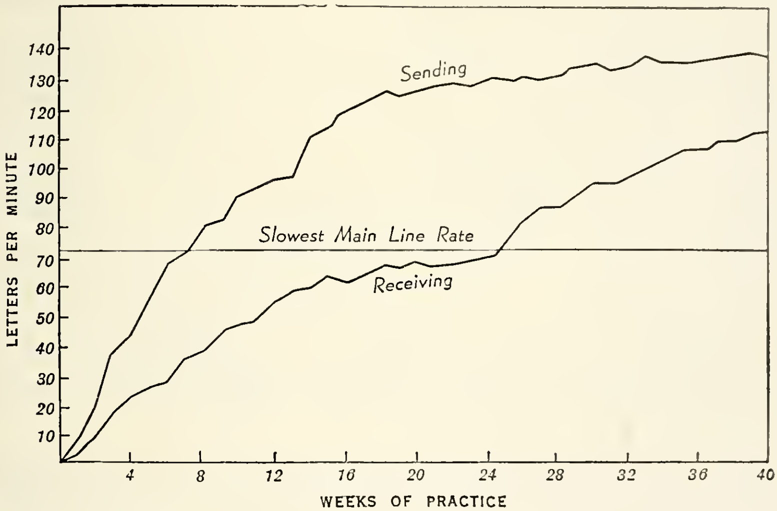

FIGURE 15.6. Learning curves obtained in the process of learning telegraphy, both receiving and sending. (After W. L. Bryan and N. Harter, from R. S. Woodworth, *Psychology,* Henry Holt and Company, Inc.)

have different upper limits, due to inherent limitations. Some individuals approach their physiological limits sooner than others, due to differences in learning ability and to strength of motivation.

Plateaus in the Learning Curve. In the curve for receiving we see that at the end of the 40th week an upper limit seemed to be near. But we cannot be sure of this, since there was a distinct tendency to level off, before, beginning about the 16th week, after which came another spurt in rate of learning. Some curves show such an early leveling off as to become practically horizontal for a time. We call these phenomena in the learning curve, *plateaus*. In the receiving curve of Fig. 15.6, the leveling off near the 40th

week might be just another plateau. We cannot tell unless the practice is continued beyond 40 weeks.

Higher Units of Response. There may be several reasons for a plateau in a learning curve. A period of lowered motivation would result in one. The persistance of some poor method might become a temporary handicap that impedes progress.

Assuming constant motivation and otherwise normal conditions, however, there is a much more significant cause for plateaus, as a rule. This cause is a change of method. In receiving telegraphic messages, for example, the typical subject begins by taking each letter as it comes. The letter is the unit of perception. When a certain proficiency is gained with this method, and when forced to speed up his reception, the subject groups letters in short words and phrases. He recognizes not only T, H, and E, but THE, in code, as one unit. Other frequent combinations, such as TION, PRE, and CON, emerge as units. This would account for the leaving of the plateau. The flattening out at the plateau, we might say, is because the operator had reached his physiological limit for his first method, his letter habit. A second plateau would be left behind when long words and short phrases emerged as still higher units.

The same phenomenon is found in learning curves for typing. It might be expected to occur in the telegrapher's curve for sending, and there is just a slight hint of a plateau at the 12th week. It may be that when plateaus do not clearly occur, the individual makes the transition more gradually, overlapping the two methods more completely.

Sensori-motor Overlap. Another important change in the learner's performance, whether in receiving telegraphic code or in typing, is the development of overlapping of stimulus and response. By this is meant that with practice he can let his responses lag behind the signals that touch them off. In receiving code, he is hearing signals well ahead of his writing. What he writes at one moment is in response to earlier signals. While he writes in response to earlier signals he is listening to later ones. The good typist while typing from copy, or from her thoughts, skillfully handles some lag. A series of responses flows along at a short

time interval after the flow of corresponding stimuli. This is much more efficient than waiting until each response is made before noting the next stimulus.

Other Types of Learning Curves. It must not be supposed that learning curves for all kinds of tasks are of the same form, or that all resemble those in Fig. 15.6. Occasionally we find almost the reverse trend; a very slow progress in the early stages of practice, and an increased speed of learning later. Such a curve would resemble line C in Fig. 15.7. Still others may form straight lines

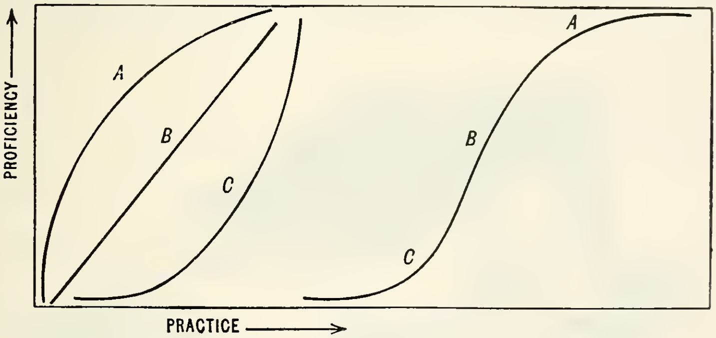

FIGURE 15.7. Types of learning curves and the theoretical complete learning curve.

slanting upward, showing a constant rate of improvement, like line B. In either of these two cases, it is almost certain that had the practice been carried much further a physiological limit or a practical limit of some kind would have been approached, and the curve would then level off, showing the usual later slowing-up of the rate of learning.

It has been suggested that every complete learning curve for a single, unified task looks like the S-shaped line in Fig. 15.7. If that is the case the three lines, A, B, and C, are simply segments of the complete typical learning curve. Such complete curves have actually been found in some experiments. The frequent kind of curve, with its rapid rate of learning at first, would mean that the individual has not started from scratch; he already has some proficiency in performing the "new" task, which is not entirely new for him.

The explanation of plateaus is that the task being learned is

a composite one, having simple and complex tasks or methods, combined. The simple components are mastered first and the more complex ones later. The plateau comes as a kind of "lull" between the two. From what we found about the shift from lower to higher units, there seems to be much logical basis for this idea.

Transfer of Training

It was just suggested that the individual comes to many new tasks with much aid from previous learning. This is true. When one habit or skill facilitates the learning of a new one, we say that there is a *positive transfer of training*. There

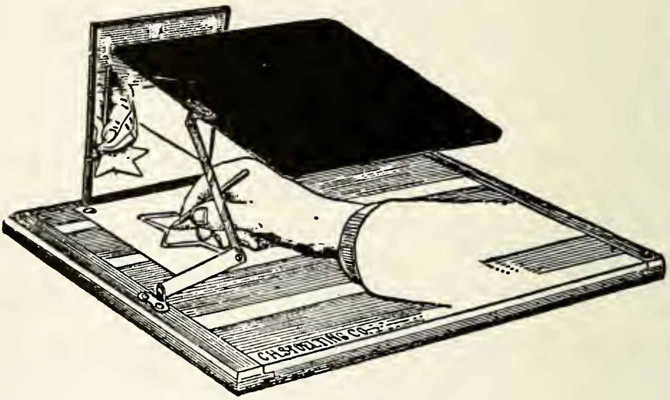

Figure. 15.8. The mirror-tracing apparatus used in the study of transfer and interference in learning. (Courtesy of C. H. Stoelting Company.)

are also times when an old habit actually interferes with the formation of a new one. This is called *negative transfer*. The two kinds of transfer are well illustrated by a favorite laboratory experiment in mirror tracing.

The Mirror-Tracing Experiment. Fig. 15.8 shows the kind of apparatus used in this experiment. A six-pointed star drawn with parallel lines to form its boundaries is placed so that the subject can see it only in the mirror. With his pencil in his right hand, he is told to trace the outline of the star as rapidly as he can, keeping always within the narrow space between the parallel lines. The difficulty of doing this while guiding the hand from what

he can see in the mirror, lies in the fact that the up-and-down direction appears completely reversed. To make matters worse, the right-left dimension is unreversed. The subject must build up a new set of eye-hand associations, or coordinations. These coordinations are in conflict with his customary ones when not using a mirror. Negative transfer is an important factor, at least so far as his up-and-down movements are concerned. After some fifteen trials, however, most persons show real progress, some being able to negotiate all the turns without error and at speeds that approach their limits.

When the new set of eye-hand coordinations are thus learned with the right hand, the experiment is repeated with the left hand. Almost without exception positive transfer is found; it takes less time and fewer errors than you would expect without any training at all. Similar transfer of training can be shown when the feet are used in the same task. Transfer is more certain when the original training has been complete and the habit stabilized.

Transfer in Education. Transfer has been a very old question in education. It used to be thought that education was a process of strengthening a few general mental powers, like reasoning, memory, and observation, through exercise of those powers. One improved his reasoning powers by taking courses in logic and mathematics; his memory power by studying languages; his powers of observation by studying laboratory science, and so on. The assumption, based almost alone upon faith, was that once you were trained to think in mathematics, you could be a good thinker in politics or in business; once you had cultivated your memory in languages, you could remember the daily routine and the facts related to your occupation in life. This theory of education was called *formal discipline.* School subjects were to be studied for their disciplinary value. Our curriculum still shows the effects of this theory.

Experiments on Transfer in School Learning. The early experiments by psychologists at first dashed this idea to the ground. Practicing memorizing of one kind of material like poetry did not help appreciably the power to memorize other kinds of material, unless the two were quite similar. Practicing to observe accurately

the length of lines, did not carry over and improve accuracy in observing areas.

On a grander scale, 13,000 high school children in New York were given some psychological tests involving reasoning, number work, vocabulary, and the like, at the beginning of the year.[11] During the year some studied sciences, some languages, some fine arts and others domestic science. They all took the same kind of tests again at the end of the year. Which high school subjects should raise the standing in these tests the most? The greatest positive effects were evident in those children who chose to study sciences, mathematics, business arithmetic, and bookkeeping. The least gain was found in those studying dramatics and domestic science. The differences were small; and they may have been due, in large part, to the fact that the brighter children, who keep growing more rapidly at high school age, chose to study the more difficult subjects of mathematics and science.

Learning Not Entirely Specific. Other experiments, however, show that some transfer does occur. Learning is not entirely specific, yet it is decidedly not so general as held by the old theory. In a study of 403 college freshmen who took the same psychological tests stressing number work and vocabulary before and after their first year, those taking mathematics improved more in the number tests, and those taking English and language improved more in the vocabulary tests.[12] Here the transfer is very direct, although not very specific. Another interesting fact was that students who took English and languages and no mathematics were more likely than not to lose in the number tests. Whether this is a case of negative transfer or whether it is simply due to forgetting of number habits or to a waning interest in number tests, is hard to say.

Other experiments show more evidence of transfer, and under what conditions it is likely to occur. Much depends upon the way in which a thing is learned and the way in which it is taught. *Transfer means generalizing what one learns.* A generalized habit is one that can be set off by a variety of similar stimuli or situations. Similarity between situations and the ability to detect similarities are important keys to transfer. A mental set to seek for similarity is also important. One student learns a principle as an isolated bit of information. Another looks around to see where

it may apply. The latter not only retains the information longer, but also gains vastly more use of the information later.

It is safe to say that there *is* much transfer in education. If there were none, we should not be justified in teaching anything except drill subjects and tool subjects. But just how extensively any new item of learning will transfer and function in the life of a pupil is a question. Every claim that a subject yields general habits or skills that transfer to many situations must be accompanied by experimental proof of transfer before a psychologist is ready to accept that claim. We still need very extensive experiments to show when, where, and why transfer does or does not take place from certain school subjects. Dogmatic statements on this problem are to be questioned.

Summary

Much learning, if not all, is of an active sort. The individual is motivated to strive toward some goal. The situation is a new one, calling for a pattern of movements he has never made before. He tries this method and that one, fails, and tries again, until some method succeeds.

Not being able to analyze the situation by means of his sensory equipment alone, he cannot make the proper movements immediately. Even after succeeding by "accident" he may not be able to observe the reason why. But in repeated trials, the false moves are eliminated and the successful ones are repeated more and more promptly, until they come immediately, when he is faced with the situation anew. The "punishment" following wrong responses works to inhibit them in the future, and the "reward" following correct movements tends to facilitate the excitation of those movements in response to the same situation in the future. This is a brief picture of learning as a result of trial and error.

If the situation is simple enough, however, and if the individual's brain has sufficient organizing power, he may see some significant relationships in the situation, which will enable him to make an adequate pattern of movements. If this is the case, we say that the individual has had insight. Insightful learning is more characteristic of the higher animals, particularly the anthropoid apes, and man. But much of man's learning is decidedly without

insight, and some of that in lower animals may be with insight. The solution of a new situation is not confined either to trial and error, or to insight. The two frequently occur together.

The acquisition of human skill is typically a matter of trial and error. It is beyond our powers of sensory organization to see just what intricate pattern of muscular contractions needs to be made in the skilled act. Repeated success and failure are required in order to shape the smooth-running, perfectly-timed pattern of the expert. The rate of learning in trial and error is represented graphically by means of a learning curve. The rate of improvement is rarely uniform, but follows certain typical forms, often with periods of little or no progress sandwiched between periods of more rapid progress.

From the standpoint of education, a most important problem of learning is whether the mastery of one learned task will facilitate the mastery of others. Actually, we find that there is negative transfer as well as positive; that there is less transfer of school education than was believed by educators of a half century ago; and that the transfer of specific habits is much easier to demonstrate than the transfer of general powers of thinking and remembering and the like.

Questions

1. Show how learning to avoid a blind alley in a maze can be considered as a conditioned response.
2. Show how a maze-learning problem is a good analogy for learning in everyday life, pointing out similar factors or elements.
3. Explain why the learning curve in Fig. 15.4 looks so different in shape from those in Fig. 15.6. Is there really any essential difference?
4. How much truth and how much error is there in the saying that "Practice makes perfect"?
5. Explain why the method of "negative practice" works and why it sometimes may fail.
6. Cite instances to show how, in the regulation of city traffic, the psychological rules regarding rewards and punishments are followed or violated by those in charge of enforcement.
7. If you were made a dictator in charge of the problem of crime, what changes would you introduce in the treatment of criminals? Base your proposals upon the principles of learning.

8. Make a list of conditions favoring insightful learning and another list favoring the resort to trial and error, in the solution of problems.

9. In general, what varieties of learning may be classified as sensory? As motor? As sensori-motor? Explain.

10. What difference would it make in our educational procedures if there were little or no transfer of learning? Suggest specific changes in the curriculum or in aims of certain courses that would result.

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CHAPTER XVI

Memorizing

THE EMPHASIS in this chapter is upon human learning in general and upon verbal learning in particular. The ease of learning verbal material, whether it be a speech, a poem, a play, a vocabulary in some foreign language, or a telephone number, depends upon many factors. Many of these factors are within our control. Everyone values highly an efficient memory, and rightly so. The best possible "memory course" is a chapter on the psychology of learning. For an efficient memory, effective learning is more than half the battle. One must do more than get acquainted with the principles of effective learning, however, in order to have a good memory. One must know when to apply these principles. Furthermore, it always takes some effort to apply them.

Some Laws of Memorizing

The Memory Span. Every normal adult can remember, at least for a moment, an ordinary telephone number composed of four or five digits, that he has heard but once. Fortunately for us, telephone numbers are not as long as eight or ten digits. We should probably not be able to remember them even though they were spoken to us twice. This suggests a real limitation upon our learning ability. The extent of this limitation can

be determined for each person by repeating to him series of digits, or of letters, or of words, of different length, to see just how long a list he can reproduce immediately. Two such lists follow:

7 3 1 9	6 1 9 3
2 8 4 7 3	7 3 8 5 2
9 7 1 3 6 4	8 4 2 9 6 1
8 3 6 4 7 2 1	5 8 2 9 1 6 3
2 8 3 5 4 6 9 7	2 1 4 8 9 5 3 6
6 5 9 2 7 4 1 8 3	2 6 1 4 8 7 3 5 9
7 4 3 9 8 6 1 4 2 5	4 3 8 9 6 1 4 2 7 5

Most individuals have a variable upper limit. At one moment they may succeed with a list of eight digits and at another moment they may fail with six. But in a large number of trials, the longer the list, the larger the proportion of failures. We take that length of list that the individual can recite correctly 50 per cent of the time as his memory span, when we wish to be very exact. The only difference between memory span and the span of apprehension (see Ch. XIII) is that, in this case, the items are exposed or spoken one at a time. For the span of apprehension they are presented simultaneously.

For the average student the memory span for digits is about seven. He can retain series of six digits correctly about 80 per cent of the time, and five digits 95 per cent of the time. The spans for letters and for words are somewhat smaller.

Memory Span and Age of the Subject. The memory-span test has been a favorite in many of the individual tests of intelligence or mental maturity. In the Stanford-Binet tests (see Ch. XXI) the child has three chances at a list of each length. If he is correct once in three trials with a list of five digits but with none longer than five, his span is taken as five. This is the span of the typical eight-year-old child, because a majority of eight-year-olds can achieve this standard. Based on the standard of one success in three trials, we have the growth curve for memory span as given in Fig. 16.1. Between the ages of 3 and 16 the size of the span has been well established. The dotted lines in Fig. 16.1 merely hint as to what happens to the span below the age of 3 and above the age of 16.

The Position of an Item in the Series. When trying to recall a list of items longer than your memory span after a single hearing, you will almost invariably find that the first and last items in the list are easiest to reproduce. The middle section is the first to drop out. A systematic study of this fact was once made in the following manner: The items were not digits, but three-place numbers. Lists of 10 items were exposed, one item at a time, for 2 seconds each. In the second showing, as each item appeared, the subjects

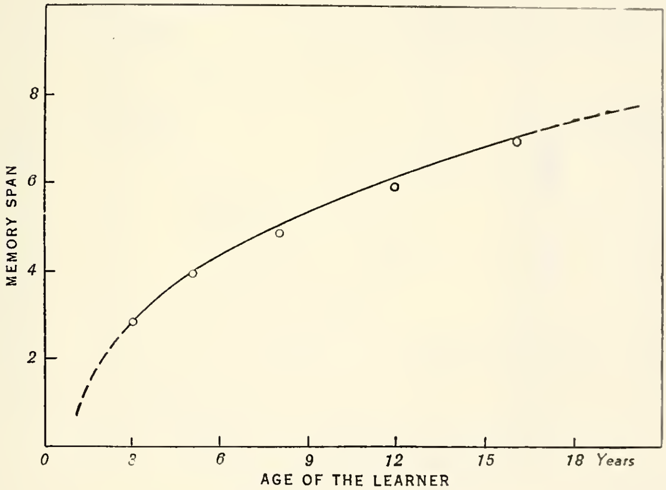

FIGURE 16.1. The relation of memory span to age.

were to try to anticipate the item following it. The percentage of correct anticipations could then be found for every position in a series. The series would be repeated until completely learned, that is, until all anticipations were correct. Fig. 16.2 shows a sample of the results, which are quite typical. The number of the trial is given with each curve, and each curve shows the relative strength of the learning at every position in the series. We see that the first items are learned more quickly than the last ones. The ones learned last are about three-fourths of the way from the beginning of the list.

A number of factors may conspire to favor the first and the last items in a list. Most important, perhaps, is the lack of interference.

The middle items have others both before and after them; the terminal ones do not. The individual is strongly set to learn when the first ones come. After they have come he is set to retain them, and this weakens his set to grasp the next ones.

When the psychogalvanic response is registered during the memorizing of a list of items like this, greater galvanic deflections are found near the first and last of the series, in very close correla-

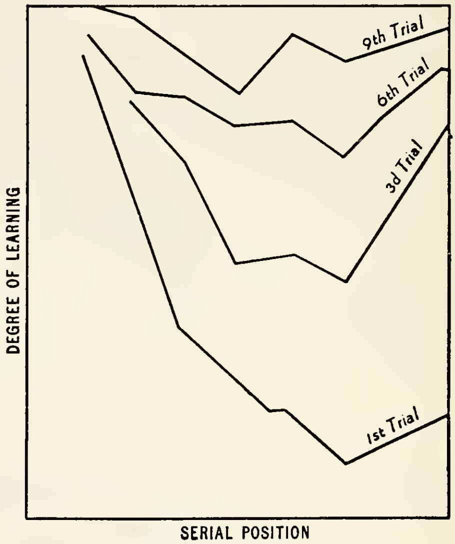

FIGURE 16.2. Curves showing the relative ease of learning at different positions in series of items. (From E. S. Robinson and M. E. Brown, "Effect of serial position on memorization," *Amer. J. Psychol.*, 1926, 37, 538-552. Courtesy of the *American Journal of Psychology*.)

tion with the ease of learning.[1] The galvanic response indicates greater alertness, tension, and perhaps some emotional elements. In other words, some emotional reinforcement is a factor. The moral for the learner in all this is to remember the disadvantage of the middle items and to try to compensate for it.

The Length of the Series and Ease of Learning. When the series of items is longer than the memory span, additional repetitions eventually overcome the interferences in it. But because a person can memorize a list of six items in one trial, on the average, it does not follow that he can memorize twelve items in two trials,

or eighteen in three, adding six new items at every repetition. We should expect that the longer the list, the greater in proportion is the number of repetitions required.

It is customary to take as the measure of *complete mastery* of a series, the number of repetitions necessary to enable us to recite it once without error. It is assumed that all material brought just to this degree of memory is equally well learned. The number of trials required to bring it to this point of complete mastery measures the difficulty of learning it, provided effort and other factors are kept constant. If the same subject memorizes several lists of each length, let us say of 10, 15, 20, 30, and 50 items, the average

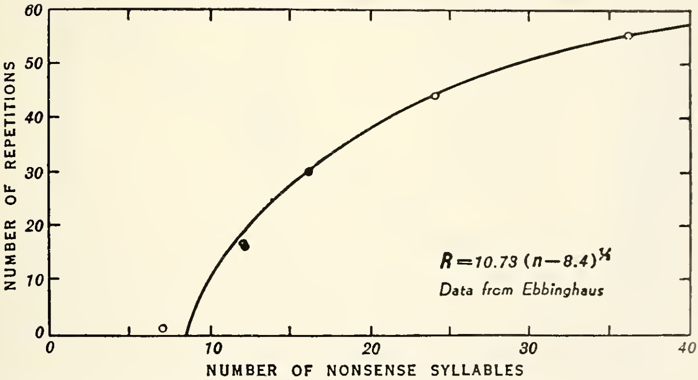

FIGURE 16.3. The relation of difficulty of learning, measured by the number of repetitions required to master a list, to the length of list. (Courtesy of L. L. Thurstone.)

number of repetitions needed to memorize each length of series will measure the difficulty of learning that number of items for him. This has been done with a number of different individuals as subjects and with different kinds of material. The typical result is shown in Fig. 16.3 for one subject. Such a law enables us to predict just how long it should take the subject to master a series of the same kind of material of almost any reasonable length.

Frequency and Strength of Memory. It is customary to take for granted that in memorizing, one repetition makes just as much impression upon the brain as any other one. Ebbinghaus, the pioneer who brought memory into the laboratory, demonstrated

that, at least within reasonable limits, it is true that each new repetition adds the same amount to the strength of the impression in the brain (see Fig. 16.4).

Overlearning. Very briefly, Ebbinghaus's method to give varying numbers of repetitions to series of the same length, and then, at a later time, to test the amount of retention. Ebbinghaus found that at least up to 64 readings, all repetitions seemed equally effective. Beyond this he suspected some diminishing returns. But 64 repetitions carried learning far beyond the point of complete mastery.

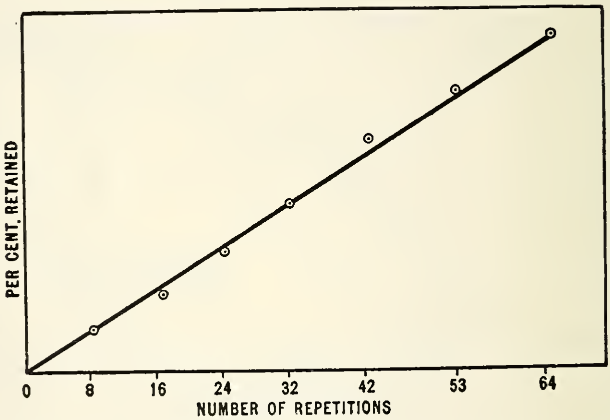

FIGURE 16.4. Relation of the strength of impression of a list, as measured by the per cent retained, and the number of repetitions given to it. (After data of H. Ebbinghaus.)

The striking thing was that even after material is learned to the point of perfect recall, it pays to continue to practice it. Repetitions over and above those required for complete mastery we call *overlearning.* Others have found that as much as 50 per cent overlearning is highly economical, but more than that is not.[2] Bright subjects are said to gain more from overlearning than dull ones. Certainly when one needs to memorize material for anything later than immediate recall, some overlearning must be done. And the longer we wish to retain the material, the more overlearning we must give it.

Factors Influencing Learning

Kind of Material. It is to be expected that some kinds of material are harder to memorize than others. But it takes careful experimentation to find out just *how much* harder they are and why. Poetry is generally easier than prose, and prose is easier than lists of disconnected words, and these, in turn, are easier than nonsense material. Consider the four following lists of items, mostly monosyllables but differing in the possibility of organization and meaning.

Nonsense Syllables	*Meaningful but Disconnected*	*Meaningful Words Logical Sequence*	*Words in Sentence*
FET	LID	HAT	THE
GUF	NOT	HEAD	SAD
TEK	GAP	TIE	OLD
RIN	FIG	NECK	MAN
NOL	COW	COAT	PUT
FEJ	MET	BODY	OUT
LAV	LAW	MIT	HIS
GIX	TOP	HAND	BIG
REL	NOW	SHOE	FAT
FAP	AND	FOOT	DOG

Lists similar to these were memorized in different orders by 25 students, some beginning with the nonsense syllables and some with the sentence. The average number of trials needed to master each kind of material may be seen in Table 16.1. This gives a rough idea of the relative ease of memorizing nonsense versus meaningful material, and logically connected versus unrelated material. Some subjects try to inject meaning into their lists of syllables as an aid to associating them, and they attempt to inject meaningful connections between unrelated words. Undoubtedly this is a great help. Memorizing that makes use of merely the direct sensory or motor connections we call *rote learning*. Logical and meaningful learning is vastly more efficient and useful when it can be introduced.

TABLE 16.1.—AVERAGE NUMBER OF TRIALS REQUIRED TO MASTER FOUR KINDS OF MATERIAL

Type of Material	*Average Number of Trials*
Nonsense syllables	9.3
Unrelated words	5.7
Related words	3.9
Words in sentence	1.6

Sense Modality. Through which sensory avenues is learning most efficient? This is an important educational question. The general opinion seems to favor vision over hearing when comparing the two important avenues. A third sense is usually overlooked, namely, kinesthesis. This sense is used when reading aloud or when writing, drawing, or making gestures. Experiments have often shown that the general opinion is correct, but that a combination of the senses is by far the best. A recent study by Port placed his methods in the following order from best to poorest: [3]

Reading and listening combined.
Writing from dictation.
Reading aloud.
Silent reading.
Oral repetition of what is heard.
Listening.
Copying.

Much probably depends upon what one is accustomed to, upon his habits of attention, and upon other factors. As usual, the rules given here apply, "everything else being equal."

Age of the Learner. The old saying that "you can't teach an old dog new tricks" has dominated human thought for a long time. Like many a glib saying, the more it was repeated the more firmly it was believed. There is some truth in it, of course, but until recent years no one stopped to ask how old the "dog" had to be before he ceased to learn. It should be said immediately that no one is ever too old to learn something. The question is more fairly stated by asking: At what age does ability to learn reach its greatest height, and at what age does it begin to decline?

A single answer cannot be given to this question. One reason is that it depends upon the kind of thing to be learned. Another reason is that people differ from each other in the rate of development and decline. Jones and Conrad have given us an answer for average people in the learning and remembering of things seen in an ordinary motion picture.[4] They asked 765 subjects, aged from 10 to 60 years, to sit through three picture shows and immediately after each one to take carefully prepared written quizzes on what they had seen. Since the reports were given almost imme-

diately after experiencing the material, they measure learning and not the ability to retain for any appreciable length of time. The change in ability that goes with increasing age is best seen in the form of a graph (see Fig. 16.5). Note the rapid rise in average scores between ages 10 and 20. The peak of ability comes at about the age of 23, then a very slow decline sets in until the age of about 45, and a more rapid decline after 45. But note that all adults average better than ten-year-olds do. This does not support the common idea that young children are the best memorizers.

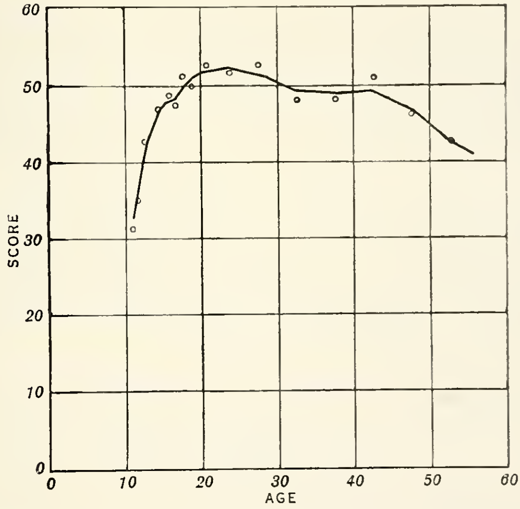

FIGURE 16.5. Relation of the ability to remember visually observed events (motion pictures) and age of the individual. (After H. E. Jones, H. Conrad, and A. Horn, courtesy of H. E. Jones and the University of California Press.)

In a number of other learning tasks, including learning to write with the nonwriting hand, learning a new foreign language, learning school subjects like arithmetic and reading, and learning to draw lines accurately, Thorndike has shown again and again that adults can learn more rapidly than children. Teachers who keep on taking college courses show undiminished learning ability to the age of 50. When any individual begs to be excused from learning because of age, unless he is actually growing senile, he is giving an excuse instead of a reason.

Sex of the Learner. Almost always girls show a superiority over boys of the same age, on the average, in tests of memorizing and in school learning. Whether there is a real inherited sex difference in memory ability, we do not know. A part of the superiority in school marks of girls must be attributed to other factors, their greater cooperation and their greater interest in the type of work done in school.

Motivation. As in all types of learning, the greater the motivation the more there is impressed upon the brain to be remembered. Human motivation often includes an intention to learn or to memorize or to remember. Things we experience without intending to remember impress themselves upon us because of their intrinsic interest, or because of their use to us. In this sense, motivation provides us with "unconscious intentions" to remember.

Learning Without Intention. Thousands of things, visual objects, sounds, and the like, pass by us during the day, most of them without even catching our attention. And many that do gain our attention seem to be forgotten almost as quickly as they came. Do they leave any impression at all?

A psychologist once obtained the cooperation of a willing subject in an experiment on memory. His subject was seated before an apparatus that exposed nonsense syllables one by one. The apparatus was started, exposing the list from beginning to end, over and over again. The psychologist had forgotten to give his usual instructions for the subject to signal to stop for a test of what he had learned. After about 50 times through the list he asked the subject, "Haven't you learned your syllables yet?" To which the subject replied, "Oh, was I supposed to memorize them?" He could not recite them. Yet other tests have shown that in such a case some of the items in the list may come to the subject's mind spontaneously at some later time.

The real test of impressions here is to ask the subject to relearn the items. This is what Burtt did in a very striking study of memory in a young child. Beginning when the boy was 15 months old, Burtt read to him 20 lines of Greek drama every day. Every three months until the boy was three years old, a new set of 20 lines was

begun. At the age of 8 years and 6 months the boy memorized some of the same material and also some new sets of lines that he had never heard before. While this new material required a total of 433 repetitions, the old required only 317, a saving of about 27 per cent. At the age of 14, the boy relearned more of the old material and also some new material. There was still an appreciable saving, but it was much decreased. This is a striking demonstration that even very nonsensical material, having only an auditory pattern, can be impressed upon a young brain with little, if any, conscious intention to learn.[5]

The Reliability of Testimony. The witness in the court of law is called to the stand, takes his oath, and is then expected to give the court some facts that he has observed concerning the case. Let us suppose that he has been an eyewitness to a crime or an accident. How much of what happened before his eyes can he observe, how much of what he observed can he retain, and how much error will creep into his report? Who are good witnesses and who are not? How can one best obtain the truth: from the story told by the witness or from questioning? Psychologists have been at work upon these questions for many years. The problem is interesting here because the average witness has no special intent to observe or to remember. His memory for such facts is usually incidental, that is, without intention.

Tests show that even when the witness intends to observe and remember the facts, his report will be far from complete and will contain many errors. In the laboratory or the classroom, pictures can be shown or short dramatic scenes can be enacted before a class. Even with intent to remember a possible list of 60 facts, the average student may report upon only half of them. Of these, less than 90 per cent may be correct. When cross-questioned, the average student may report upon 75 per cent of the facts, but there will be more errors in his answers. Questions often suggest errors and lead the person to attempt to report things of which he is less sure. When the average person says he is sure of a fact, however, you may usually depend upon it to be more accurate, especially if he will swear to it. But there remain errors even in sworn statements. If the event is unexpected and there is no set to remember facts,

the percentage of accuracy may drop to 3 per cent, whereas, for intentional learning, it is likely to be about 90 per cent.

Pleasantness and Unpleasantness, and Learning. Many experiments have tested the effect of likes and dislikes for the material and the ease of learning. There is reasonable agreement that material that is judged as pleasant is easiest, that material judged unpleasant is next, and that indifferent items are least easy. The easy learning of pleasant material reminds one of Thorndike's law of effect that a satisfying state of affairs helps learning. But the unpleasant material is not less easily memorized than the indifferent, as one would infer from the same law of effect. An

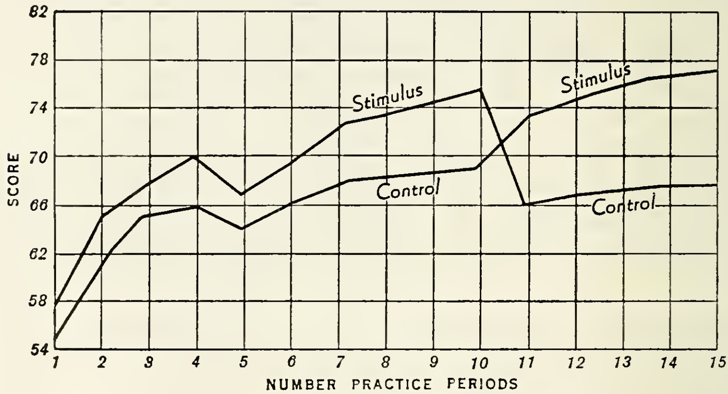

FIGURE 16.6. The effects of knowledge of attainment and other motivating factors upon the rate of learning. (After W. F. Book, from A. M. Jordan, *Educational Psychology,* Henry Holt and Company.)

annoying state of affairs is supposed to work *against* the forming of connections.

When the psychogalvanic response is recorded along with memorizing in this experiment, it is found that both pleasant and unpleasant items are inclined to produce slight emotional reactions, indicating increased alertness and concern.[6] We may suggest the theory that a second factor of general emotional reinforcement is probably at work here in addition to the law of effect. Like all theories, this is a guess, and is not to be accepted as fact until supported by further crucial tests.

Knowledge of Progress. The more definitely the subject knows his progress, the more rapidly he will learn as a rule. This

is shown by a neat experiment performed by Book. Two groups of college students underwent a number of training periods in a task in which they could be scored during each trial. One group was told about scores as they went along, and the other group was not, for the first ten days. The learning curves in Fig. 16.6 show how the motivated group kept above the unmotivated group and widened the distance between them in scores. After the tenth day the two groups were reversed; the ones formerly motivated were no longer told their scores and the formerly unmotivated group was now informed. The learning curves show that the two groups definitely exchanged places. The formerly unmotivated one does not take up at the high level at which the formerly motivated one left off, showing that they really did not learn as much during the first ten trials. The formerly motivated group, however, dropped far below the level reached by the unmotivated group in ten trials. Loss of the opportunity for knowing how well they were doing was apparently worse than never having known at all.

Some Efficient Methods of Learning

The Whole Method. Numerous studies have been made to find out whether, in memorizing a quantity of material or in mastering a complex skilled act, it is better to practice the entire task as a unit or to break it up into sections. Sometimes the answer is in favor of the whole method and sometimes in favor of the part method. It depends very much upon the amount of material, the kind of material, the age of the learner, and other factors. There are advantages and disadvantages on both sides.

In general, the whole method has an advantage when the material is not too long and has a natural unity or logical sequence to serve as a framework upon which to attach the parts. It shows its advantages with older and more practiced memorizers. It is generally better with poetry, even for children.

The part method has the advantage of keeping the learner motivated; he can know better what progress he is making. It is better when the material is long or difficult and when the learner is easily discouraged. The part method may leave a selection of prose or poetry broken into sections when memorized, unless special pains

are taken to associate the end of one section with the beginning of the next. If a selection is broken into parts, it is best to make the breaks come at different places at different trials, and to insert a few total repetitions. The greatest waste of time is to memorize a first section, then read through sections one and two repeatedly while memorizing section two, and so on, overlearning the early parts at the expense of later ones.

The Recitation Method. After the first reading or two, which is better procedure—another reading or an attempt to recall the material with promptings where one fails? Undoubtedly the latter. Just how much better, one can scarcely realize without an accurate test of the matter. Such a test was conducted by Gates, who used as his material, lists of 16 nonsense syllables, and also short biographies about 170 words in length. The subjects were children. Each study period was 9 minutes long. The subject read until given a signal to "recite," when he put aside the paper and tried to recall the material. When he could not recall, he glanced at his paper again. The percentage of the time spent in recitation varied from none at all to 80 per cent in different trials. Sometimes, there were recall tests immediately at the end of the study period, and at other times four hours later. Table 16.2 shows what percentage of the material was correctly recalled under each set of conditions.

TABLE 16.2.—THE ADVANTAGE OF RECITATION OVER READING IN MEMORIZING

Percentage of Time Given to Reciting	Material: Nonsense Syllables, Percentage Remembered, Immediately	4 Hours Later	Material: Short Biographies, Percentage Remembered, Immediately	4 Hours Later
None	35	15	35	16
20	50	26	37	19
40	54	28	41	25
60	57	37	42	26
80	74	48	42	26

For the nonsense syllables it will be seen in Table 16.2 that the increase of time spent in recitation yielded increased learning even up to 80 per cent or 4/5ths of the learning period. For the biogra-

phies there was no appreciable gain in learning after giving 40 per cent or 2/5ths of the time to recitation, although even 80 per cent of the time given over to recitation was better than none at all.

The reasons for the much greater effectiveness of reciting lie chiefly in the added incentive or motivation. In this method you know which items need further practice and which ones do not. You have some knowledge of progress. You have to be more active than in mere reading. More sense modalities are brought into play, also some muscular activity. In reciting the material you are practicing precisely what you are going to be called upon to do later in recalling it.

Spaced Learning. Almost without exception, more gain results when practice periods are spaced some time apart than when they are bunched together in time. This holds for acquiring skill, and for memorizing. One of Starch's experiments is a good example of what happens when repetitions are distributed, as compared with when they are not. The task was substituting numbers for letters according to a new code that the subjects had to learn. There were four groups of subjects, who practiced a total of 120 minutes, distributed as follows:

(1) 10-minute periods, twice a day, every day.
(2) 20-minute periods, once a day, every day.
(3) 40-minute periods, every other day.
(4) 120 minutes, all at one time.

The learning curves for these four groups are shown in Fig. 16.7. The 10-minute practice periods gave the greatest consistent gains, followed closely by the 20-minute practice periods. The massed practice of 120 minutes gave the least gains.

To what extent fatigue is a factor in this particular experiment is hard to say. There are really two factors involved here; length of practice period, as well as time between practice periods.

What length of practice period would have given the greatest possible gain, we do not know, but from the small difference between the 10- and 20-minute periods one should not expect much more gain from periods shorter than 10 minutes. In different types of tasks the best time might be something else. This must be de-

termined for each kind of work separately. Advantage must be taken of the "warming-up" at the beginning of any work period. This suggests that it is possible to make the work period too short for best results.

Fatigue is decidedly not the only factor in this problem. There is much evidence that something practiced and then laid aside for a time, profits more by later practice than it would have by immediate practice. There is an old law of spaced learning, known as

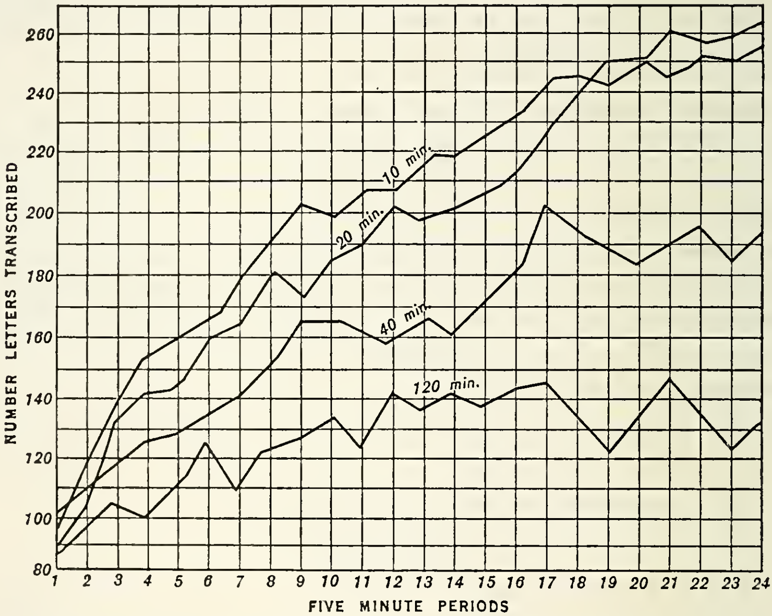

FIGURE 16.7. The effects of distributing practice upon the learning of a substitution test. (After D. Starch, from A. M. Jordan, *Educational Psychology,* Henry Holt and Company.)

Jost's law, which states: *Of two impressions of equal strength, the older of the two will gain more by the same amount of further exercise.* Some results on memorizing are given in Table 16.3. Two subjects in this experiment gave 24 readings to the same lists of material with three different spacings, 8 times a day for 3 days, 6 times a day for 4 days, and 2 times a day for 12 days. The test scores show a decided advantage for the greater spacings.

Whether once a day for 24 days would have given additional improvement, we do not know.

TABLE 16.3.—ADVANTAGES OF SPACED READINGS IN MEMORIZING

Spacings of Readings	*M's Score*	*B's Score*
8 a day for 3 days	7	18
6 a day for 4 days	31	39
2 a day for 12 days	55	53

The advantages are not always on the side of spaced learning. The application of this principle must also be made with care. No one would think of limiting the study of meaningful material, for the sake of its content, to 10-minute periods. In the study of problems depending upon insight and understanding, massed practice is usually better. Distributed practice is better for more mechanical and rote types of learning. The best spacings between reviews of meaningful material are short ones at first and longer ones later. For example, in a space of 11 days it was found that the best distribution was 3 readings on the first day, and one reading on days 2, 3, 4, 7, and 11.[7] There can also be a reduction of time spent in reading in the later intervals. In memorizing sonnets, for example, it was found efficient to reduce the time in four daily readings according to the following plan: 15, 8, 5, and 2 minutes.[8] In some such distribution of time to readings and to intervals between readings, the best use of one's working time is made.

Mnemonic Devices. There are many incidental aids to memorizing, some more or less artificial, that deserve mention. One is the introduction of grouping and rhythm. Poetry is more easily memorized than prose, because of its natural rhythm and grouping of verses. In the memory-span test, many persons devise this scheme for themselves to use in the longer stories. Two students practiced the grasping of memory-span material for a period of more than 50 days. By these special devices one increased his average span from 8.9 to 13.1 and the other from 10.9 to 14.8.[9]

There are many artificial systems for forming associations between words and letters and numbers. For example, according to one system, if you wish to remember that Charles the First was executed in 1649, the four digits would be associated with the word "sharp." In this system the "sh" sound stands for the number

"1," "a" for "6," "r" for "4," and "p" for "9." Remember that the executioner's ax was sharp, and there you have the date. Other dates can be translated similarly into meaningful words.

Most such systems are cumbersome and forced or unnatural. The alert person can do far better with only a little ingenuity, and can make his associations real and logical. Some experiments have shown that learning and, later, recall, are better when the subject makes his own relationships, than when they are given to him. They also show that commonplace and intimate connections between items are better than far-fetched or bizarre relations.[10] Systems of classifications, logical relationships, and clear thinking go a long way toward a successful memory. Application of other sound psychological laws of learning will do the rest.

Summary

The ease of memorizing material and the degree to which it is impressed upon the nervous system depend upon a number of circumstances. In lists or series of material, some of the factors are length of series, position of the items in the series, the number of items in the series, the kind of material, the sense modality employed, the age and sex of the learner, and how strongly the learner is motivated.

Certain devices or methods of memorizing have been found especially efficient under favorable circumstances. These include the whole method, the recitation method, and spaced learning. Mnemonic devices, or memory systems, are helpful if meaningful and self-instituted, but are cumbersome and of doubtful value if artificial and invented by others.

Questions

1. With the principles of this chapter as a basis, write a short essay on how to study.
2. What changes in educational practice would seem desirable in the light of this chapter?
3. Make a list of questions left unanswered by this chapter, about memorizing, particularly questions raised by the facts of the chapter.
4. Suggest other factors that may facilitate or retard memorizing, in addition to those mentioned in the chapter.

5. What advice would you give with regard to the use of the whole method, recitation method, and spaced learning, to adults who memorize: (1) poems; (2) orations; (3) plays; and (4) a paragraph of prose? Give reasons.

6. What devices that will reduce learning time can be introduced by the learner in memorizing nonsense material? Why should each device work?

7. Discuss the practice of cramming, in light of the laws of learning.

8. Apply the memory-span test to several individuals of different ages, using the material given in this chapter, or similar material. Report your results, with conclusions.

9. To test the effect of four kinds of material upon ease of learning, use the four lists given on page 393 with four subjects, and average the results. How well do they agree with those in Table 16.1?

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CHAPTER XVII

Remembering

MOST psychologists are convinced that learning produces changes in the brain, that those changes are retained for at least some length of time, and that they express themselves later by making the individual behave differently than he did before learning. This is the modern story of memory in one sentence. The old idea was that "memories" were mental entities that were kept in some sort of container. They could later be brought out of hiding again, but they retained their identities and could be weakened only with age.

According to the modern version it is modified brain structure that is retained, not mental entities. And this modified structure rarely remains exempt from further modifications between the original learning and the time of recall. We may call a modified brain structure a "learned impression" for convenience, if the change was due to learning. Its exact nature we unfortunately do not know. Well-learned patterns of response are only relatively permanent. They are not at all isolated, fixed entities. The learning of one new pattern may influence many others, favorably or unfavorably. Thus, any learned impression in the brain is subject to revisions.

Retaining and Forgetting

The Rate of Forgetting. That anything learned is subject to some forgetting is almost too obvious to mention. But no one could say, offhand, just how rapidly learned impressions are lost, and whether forgetting takes place at a constant rate or whether we forget more rapidly at first or later.

The German psychologist, Ebbinghaus, answered this question for us many years ago. After memorizing a list of nonsense syllables to the point of complete mastery, he would wait a certain time and then relearn the series. If, for example, it took an average of 20 trials to memorize the lists at first, and 14 trials to re-

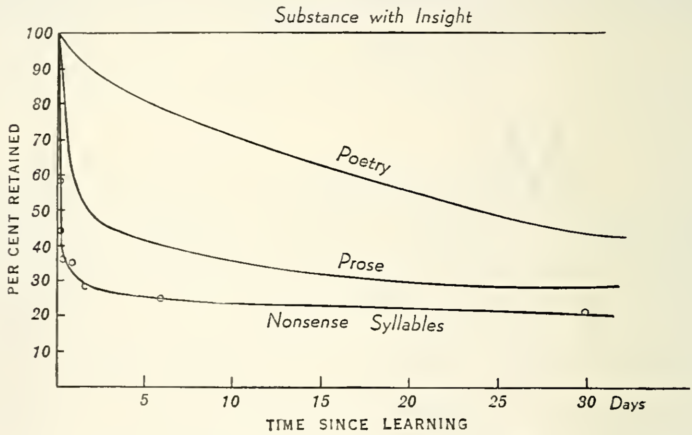

Figure 17.1. Curves of retention for different kinds of material, over a period of a month. The per cent retained is given in relation to the time elapsing since the end of memorizing.

learn them after two days, there was a loss equivalent to 14 out of the original 20 trials, or a forgetting of 70 per cent. In this way he found the loss to be very rapid during the first 24 hours. About 42 per cent was lost after only 20 minutes, 66 per cent after 24 hours, and 79 per cent after 30 days. The amounts retained after those same intervals would be 58, 34, and 21 per cent, respectively, assuming that the strength of the impression immediately after the first learning was 100 per cent.

The retention curve for nonsense syllables, in Fig. 17.1, shows how rapidly the impression in the brain was sinking. It should be

pointed out that this particular curve applies strictly to one individual, using one kind of material, and one method of measuring retention. But the general fact that forgetting is rapid at first, and then slower as time goes on, is the basic law of the rate of forgetting.

The curve of retention suggests that forgetting is never complete, for the curve always levels off at some low value above zero. Whether or not forgetting is really ever 100 per cent complete we cannot say definitely. Certain it is that memorized poetry not recalled for 40 years can be relearned more quickly than can new material of the same kind.

Factors Influencing Forgetting. A number of factors may conspire to cause a more rapid or a less rapid rate of forgetting. A few of the more important ones follow:

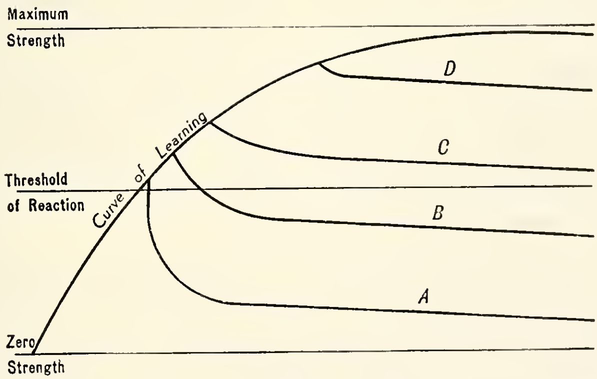

FIGURE 17.2. The influence of overlearning upon retention. The retention curves start after different amounts of original learning. The threshold of recall is the level of retention above which recall is 100 per cent effective.

(1) *Kind of Material.* As a rule, material that is easy to learn is also easy to retain. Meaningful, logically related material, and poetry are forgotten less rapidly than nonsense material and prose. Material in which insights are gained may never lose strength as long as one lives. The substance of a prose passage is retained long after the words in which it was clothed are forgotten. Fig. 17.1 suggests how well different kinds of materials are retained.

(2) *Overlearning.* Overlearning, beyond the point of complete mastery, strengthens the impression in the brain. We have all

overlearned many things to the point where instant recall is possible and perhaps always will be. One's own name, the use of the multiplication table, and nursery rhymes are examples. Fig. 17.2 shows the rate of forgetting one should expect for different degrees of overlearning. Curve A is the typical retention curve. Curves C and D represent overlearning to the point where, for a long time, there can be complete recall without further relearning.

(3) *Shock Amnesia.* Since retention depends upon the brain, anything happening to the brain may interfere with it. Apparently, impressions that are just newly formed are most subject to damage. A young man, during a football game, received a severe blow on the head, resulting in brain concussion. After waking from a period of unconsciousness, he did not remember anything about the game or even anything that happened on the day of the game. Older memory impressions seemed not to be disturbed. We call this phenomenon *shock amnesia.*

(4) *Drugs.* Milder damage to memory impressions, particularly to recently formed ones, can be produced by oversaturation of the brain with drugs like alcohol. Continued excessive use of alcohol affects brain cells with eventual loss of memory impressions in general.

(5) *Retroactive Inhibition.* It does not take a severe shock to the brain to interfere with impressions already formed. Any new mental activity following the learning of the new impressions is likely to cause some forgetting. The influence of new activity upon previously learned impressions is called *retroactive inhibition.* It is called retroactive because it seems to act back upon a previous learning. However, it can, of course, only exert its effect upon the altered brain structures resulting from the learning. The effect is noticeable when future tests of the impressions are made.

The effect is one of interference of the new impressions with old ones. New associations or connections conflict with old ones, and both suffer to some extent. The older ones suffer least if they are pleasant ones, if they are more thoroughly established, and if they can be kept more isolated from the new ones in subsequent activity of the individual.

(6) *Sleep.* In his pioneer work on memory, Ebbinghaus noticed that he did not forget as much as you would expect after 24 hours, as compared with the amount of forgetting after 8 hours. He suggested that perhaps it was because he slept a part of the entire 24 hours, but was awake during the entire 8-hour interval. Years later, two students obligingly served as subjects to test this suggestion experimentally. Each night, before retiring, they memorized a list of 10 nonsense syllables. After going to sleep, they were sometimes awakened after one hour, and sometimes after 2,

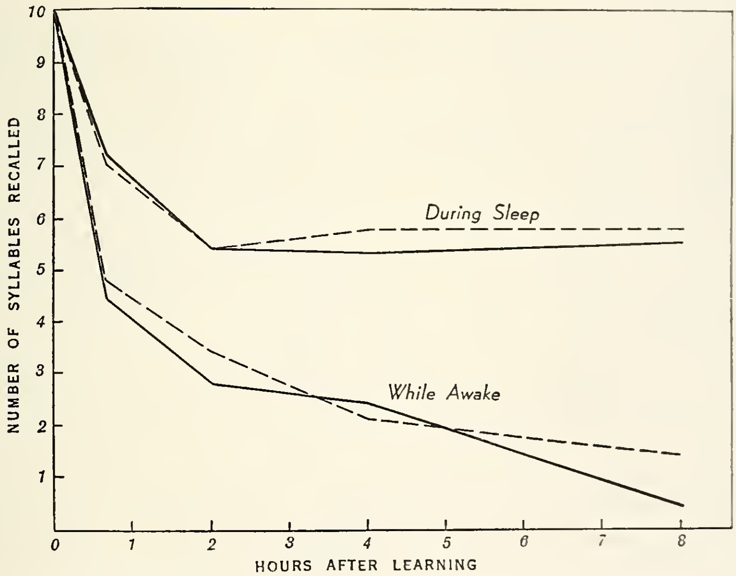

FIGURE 17.3. The effect of sleep upon the rate of forgetting. Retention curves are shown for two subjects during eight hours of sleeping and also during eight hours of waking. (After J. G. Jenkins and K. M. Dallenbach, *Amer. J. Psychol.*, 35 (1924), 605-612, courtesy of the *American Journal of Psychology*.)

4, or 8 hours, to recite what they could remember. They also memorized a list each morning, and came, during the day, 1, 2, 4, and 8 hours later, for similar tests. A comparison of their retention curves can be seen in Fig. 17.3. It is clear that forgetting goes on much more slowly while the subject is asleep than while awake.

This fact suggests that an important cause of all forgetting is retroactive inhibition. During sleep all mental activity is at a minimum, though not reduced to zero. The fact that the two sub-

jects forgot something during the first hour or two after retiring, may be due to their not going to sleep immediately. It is possible that if, immediately after learning, an individual could be put into a prolonged, complete sleep, retention might be kept at 100 per cent for an indefinite length of time, so long as he slept. The practical consequence of all this is that a period of complete relaxation or sleep immediately following learning, is an excellent thing for good retention.

Recalling

Recall may be in any form in which the original learning can take place. We revive visual images of things seen, auditory pictures of things heard, tactual images of things felt, and so on. We reproduce verbal reactions, like lists of memorized material. We give verbal accounts of things observed. We perform the skilled act, or try to tell some one else how we perform the act. It will be noticed from these statements that the recall need not be in exactly the same form as was the original learning. Having learned to recite a poem, we can later write it out. Having read and understood a printed passage, we can later tell someone the substance of it. We may regard these cases as instances of transfer of learning of a very direct and complete variety.

Factors Determining Recall. Recall is one proof that learning and retention have taken place. Yet, we cannot say that if recall fails there has been no learning or retention. Relearning tests often show that there has been retention, even when recall tests show none at all. Of two memory impressions of equal strength, other things being equal, we expect equally good recall. But one impression may be revived into action easily, the other not. It all depends upon a number of other factors. Some of the factors will now be mentioned.

(1) *Completeness of the Stimulus.* There is rarely, if ever, any recall without a stimulus. If you memorize a poem, it does not came back to you without the name of the poem, or its first line, or some part of it, or something similar to act as a cue. Memorize a skillful tennis stroke, and you do not repeat it in a game until faced with the opportunity to do so.

A possible exception to this rule occurs when a tune comes to mind as if from nowhere, and you find yourself whistling it over and over again in the midst of other activity. This apparent recall without a cue is called *perseveration.* There may be cases of actual perseveration when certain brain patterns keep acting over and over, due to previous overstimulation, as when one hears a new, catchy tune at a dance or a movie. But, in most cases, if one looks for it, he can find something in the preceding moments that could have acted as a stimulus for recall. We must remember, in this connection, that the stimulus may come from within the body as well as from the environment. It might be an emotional state, with its bodily tensions; or it might be a train of associations that touch upon the recalled activity very indirectly or subtly.

Complete cues are more certain to bring recall than incomplete ones. Bringing a witness back to the scene of the crime may set loose a new stream of associations. In the laboratory it has been shown that even a change of color of paper may disturb recall. Nonsense syllables were learned on one color of paper, and recalled in connection with a background of another color.[1] Even if the syllables were not associated with the color of the background, there was a distracting effect caused by the change. A change of rooms may or may not have a detrimental effect, but some teachers have the impression that facts learned by students in one room are often lost when transferring to another one. This has never been experimentally verified, but it is reasonable to suppose that stimuli in the entire situation may become conditioned stimuli, upon which recall comes to depend.

(2) *Mental Set.* Set or expectation has much to do with recall. Curiously enough, when subjects are set to recall learned material at some definite time, they do better than when trying to recall the same material at an unexpected time. One experiment showed an 8 per cent loss if the recall were asked for earlier than the expected time, and 17 per cent loss if asked for later.[2] Students who "cram" for examinations, with the intention of retaining the material just long enough to write the examination, often find that this is precisely what happens. Forgetting after the examination proceeds at unusually rapid rates!

In everyday life our expectations are set up by our motives. Recall is made to serve the ends and goals determined by those motives. An experiment with children shows this very neatly. Ten children were given the ordinary word-association test. They were to respond by giving one word in response to each stimulus word. They were also given, as stimuli, some simple pictures of objects drawn so as to be ambiguous, and therefore so as to allow for a variety of answers. These two tests were given to the children just before mealtime and again just after meals. Among the responses, the experimenter looked for words relating to hunger and food, names of foods or meals, or verbs suggesting eating. The number of "food" reactions to words were twice as frequent before a meal as after it. To pictures, the children gave 2.5 times as many food responses before meals as after.[3] A study of images and other activities would doubtless show the same result. It is well known that severe cravings sometimes set up recall of images of such vividness that the individual takes them for real, and, thus, he has genuine hallucinations.

(3) *Effort to Recall.* This is another motivational factor. Ordinarily, the harder we try to accomplish an act, the better we succeed, unless the effort reaches highly emotional proportions, and our actions become disorganized. What is the influence of effort upon recall?

There are many indications that effort is a handicap to recall instead of a help. Who has not had the experience of trying, with extreme effort, to recall a name, a fact, or a date without success, only to have the desired item flash into existence some time later, with no effort at all? This experience is too common to deny. Many special devices used in the attempt to revive weak and long-forgotten memories, some of which will be described later, all have one thing in common. They require the individual who is going to do the recalling, to relax and *not* to exert any special effort. On the contrary, a lawyer can prod an individual on the witness stand, goading him on to greater effort, until new facts come to light. How can we reconcile these two seemingly opposite facts?

It is probably true that the best condition for recall is an attitude of confidence, a set of expectancy that the desired items will come, and a relatively relaxed condition. Recall must be moti-

vated, but not too strongly. Effort is not necessarily a bad thing for recall, unless it keeps us on the wrong track. One should return repeatedly to the starting point, and should bring all possible cues to bear. Letting effort lapse after failure, with a spontaneous recall later, does not necessarily mean that effort was detrimental. Instead, the effort may have had much to do with the later success. The successful prodding of a witness by a lawyer may have worked because the prodding offered more necessary cues for recall.

(4) *Emotional Blocking.* Even overlearned material may be difficult to recall under emotional stress, as anyone with severe stage fright will testify. The remedy lies in the control of one's emotions. Apparently, the emotional disruption that occurs in all behavior when emotions become too strong affects recall of memorized material very easily.

(5) *Pleasantness and Unpleasantness.* Since the psychoanalysts have told us so emphatically that we forcibly repress and forget unpleasant things, and retain and recall pleasurable ones, dozens of experimental studies have been made to test this assertion. Two typical experiments were conducted somewhat as follows.

A hundred children in grades 6 and 7 learned to associate words that were pleasant, unpleasant, and indifferent with other stimulus words, in pairs. After six months, they were given the stimulus words and were asked to respond with the learned associated word. The result was typical of this kind of experiment. Pleasant words were most likely to be recalled, unpleasant ones next, with indifferent ones a poor third. Another significant result was that pleasant words were often given as substitute responses in place of indifferent or unpleasant ones.[4]

In another study of this kind, 51 students were asked to list all their pleasant and unpleasant experiences of the last three weeks. The fact that they failed to mention many events that they may have recalled makes little difference for the experiment, for the real recall test came later. Three weeks later, they were asked to reproduce the lists. At this time, 45 per cent of the pleasant and 31 per cent of the unpleasant experiences were recalled.[5] There was a possibility, of course, that the pleasant experiences would

have been reviewed more times in the meantime. But this in itself proves the truth of the greater tendency to recall pleasant more often than unpleasant things.

On the whole, there is evidence that both pleasant and unpleasant items are more easily recalled than indifferent ones; but that the pleasant ones have a margin of advantage over the unpleasant ones. The recall of early childhood memories, however, leads to a different story. We will turn to this question in a moment. First. a word by way of general conclusion about the typical experiments just described: It seems that the important factor is the degree of motivation involved, whether pleasant or unpleasant. The slight edge given to the pleasant items is, however, real, and appears to come from the general set to avoid the disagreeable and to seek the agreeable.

The Recall of Earliest Memories. When an adult is asked to tell about the earliest incident that he can recall, and to establish the age at which it occurred, this established average age is about three and a half years. When asked to rate the incident as pleasant or unpleasant, it is more likely to be found unpleasant than pleasant. One investigator found that the emotional tones of fear, joy, and anger accounted for 30.4, 27.9, and 10.3 per cent of all these early childhood memories, respectively.[6] Another found that early memories were usually of fearful, painful, or puzzling situations. A study of 554 students who rated their memories as pleasant or unpleasant, gave the results shown in Table 17.1.[7]

Table 17.1.—A SUMMARY OF EARLY CHILDHOOD MEMORIES

Sex	Number	Percentage of Memories Pleasant	Percentage of Memories Unpleasant	Average Age for Pleasant	Average Age for Unpleasant
Men	92	25.0	53.2	3.8	3.6
Women	462	35.2	42.6	3.6	3.5

* After Gordon.

Special Devices for Recall. The memories of early childhood just mentioned were recalled in the ordinary, everyday manner. There are special devices by which much more material can be recalled, even dating back to less than a year of age. These methods have been used effectively by psychoanalysts, psychologists, and

psychiatrists. They should not be attempted without the aid of one skilled in their operation. All of them have certain aspects in common, namely, relaxation and a control of attention.

(1) *Hypnosis.* Under hynotic trance, almost unbelievable recalls can be brought about. To mention a mild example first, a subject was asked, before the induced trance, what poems he had memorized as a child and could not now recite. One was Longfellow's "Village Blacksmith." Under the trance, he recited the poem without hesitation, when asked to do so. Told that he was now three years old, he was asked to describe what he saw. He reported that he was sitting in a high chair, eating cereal in a kitchen in his home in Brooklyn. His description of the situation was vivid and complete. Told that he was now eight years old, he was asked to write on the blackboard exactly as he did at that age. His handwriting showed all the earmarks of being that of a beginner, including the misspelling of his own name.

Other subjects are said to recall things they observed, and to revive reactions that they had, as a part of their behavior at ages under one year. The value of such recall depends upon the use that is made of it. It may help to get at the roots of faulty development, or, again, it may revive disturbing circumstances long since forgotten. Having recalled the memories under the hypnotic trance, the subject can be led to recall them when awake, after further work with him.

(2) *Crystal Gazing.* Some individuals can revive long-lost memories by staring steadily into a glass ball. They may actually hallucinate pictures in the ball, which is very suggestive, with its curious lights and shadows and reflections. Or they may merely have a train of associations that leads them to recalls. The ball has the virtue of centering attention, avoiding distracting stimuli, and of acting as a very ambiguous stimulus. There is nothing intrinsically potent about the crystal itself; a light bulb would work just as well.

(3) *Automatic Writing.* A few individuals can be induced to write on paper while their attention is otherwise absorbed. They themselves do not realize that the hand is active. It may write connected sentences, or it may draw pictures. They may

not recognize, later, what they have written, but it is material recalled from their pasts, and, with further writing, or by other methods, it can be identified and even recognized by them.

Recognizing

Recognition and Recall. Recognition means literally, "knowing again." When you recognize an object, you act as if you have experienced it before. Ordinarily, we realize that to recognize a name or an object is easier than to recall it. If asked to recall the advertising slogan for a familiar brand of cigarettes, you might fail, although you had seen or heard the slogan many times. If asked whether or not the slogan is "For finer flavor," you reject it immediately and with conviction. If the slogan, "They satisfy," is offered, you accept it immediately, and wonder why you could not have thought of it yourself.

The essential difference between recall and recognition is that, in the one case, the name or object is there for your perception, and, in the other case, it is not. This difference is brought out in connection with the average person's vocabulary. The number of words that one can recognize in reading is much greater than the number one could sit down and write out, even if given plenty of time.

Errors of Recognition. Mistakes of recognition are frequent and often embarrassing. Cases of mistaken identities come to our attention, if they are not actually committed by us, almost daily. There are two kinds of errors of recognition: (1) failing to recognize the familiar, and (2) false recognition of the new and unfamiliar.

We fail to recognize the familiar object because it undergoes changes, or is seen again under altered circumstances. Our set may be unfavorable, in that we do not expect to meet the object. We accept the new object as familiar, conversely, when we are expecting another, similar object. The greater the degree of resemblance, the more readily do we make the same error, even without the help of a favorable set. This is a case of equivalent stimuli, the one stimulus being able to set off the habitual responses attached to the other.

An experiment of Lund's illustrates these errors very well.[8] His material was in the form of nonsense words of five letters. Table 17.2 gives a few of them. The words in List B are the same as those in list A, with one letter changed. Those in List C have two letters changed; otherwise they are like the ones in List A.

TABLE 17.2.—MATERIAL FOR AN EXPERIMENT ON RECOGNITION

List A (original words)	List B (one letter changed)	List C (two letters changed)
GATOR	GATON	GATEN
MAREN	MARER	MARUR
DULEN	BULEN	SALEN
KUNEL	SUNEL	GANEL

The words in list A, with others like them, were exposed for only a moment each to the subjects. Later all three lists were mixed up in haphazard order and exposed again, one word at a time. The subjects were to say, at each exposure, whether or not they had seen the word before. On the average, there were errors of type one, that is, failure to recognize, in about 15 per cent of the cases. These were for the correct words in List A. For List B about 30 per cent of the responses were errors of type two (false recognitions). The change of only one letter in five leaves the words of List B quite similar to the words in List A. The percentage of errors in List C, where two letters were different from those in List A, fell to about 20. Corresponding to these percentages of error, the confidence of the subjects in the correctness of their responses was highest for words in List A and lowest for words in List B.

Confidence and Recognition. In general, the greater one's confidence in his recognitions, the more likely he is to be right about them. But in particular instances, great error may be accompanied by the utmost confidence. Only in the long run does the correlation between confidence and correctness hold. We learn by trial and error, mainly, when to have confidence and when not.

SUMMARY

The rate of forgetting is typically rapid at first and slower as time goes on. This depends upon many factors, however, such as

the kind of material memorized, the amount of overlearning, and the like. Certain other factors can intervene between learning and recall, either to foster or to interefere with good retention. Physical or emotional shocks, drugs, and many kinds of activity following the learning, may interfere. Sleep immediately following learning seems favorable to retention.

Efficiency of recall depends upon the completeness of the stimulus or the situation which serves as the cue to recall, and upon many motivational factors. Special devices such as hypnosis, crystal gazing, and automatic writing are often used successfully to revive memorized reactions not otherwise arousable.

Recognition is a phenomenon of perception, and like most perception it depends upon memory. Errors of recognition are numerous, including failures to recognize the familiar, and wrongly recognizing the unfamiliar.

Questions

1. How would you account for the different rates of forgetting for different types of material as shown in Fig. 17.1?

2. What bearing does the effect of overlearning have upon the preparation for course examinations? In preparation for a profession?

3. There are two current theories of forgetting: one that forgetting is due to the lack of exercise of the learned impression, and the other that it is due to retroactive inhibition. What facts in this chapter point to each theory? What is your own conclusion?

4. What advice would you give to an actor or speaker who, because of stage fright, often has difficulty in recalling his learned material?

5. How can we account for the fact that, of early childhood memories, the unpleasant ones are most likely to be recalled, whereas, for more recent memories, the pleasant ones are more easily recalled?

6. What factors do the special devices for aiding recall, *i.e.,* hypnosis, crystal gazing, and automatic writing, have in common? What is the probable secret of their success?

7. Is it possible to recall an item that we do not recognize? If so, give an example.

8. Quick learners, as a rule, also retain better than slow learners. Explain. Why should the popular belief to the contrary have grown up?

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CHAPTER XVIII

Thinking

THOUGHTS and Things. The average person makes a distinction between thoughts and things. His thoughts are his own, but things he regards, in a sense, as the common property of all who experience them. This is one common-sense difference. But there is also an important psychological difference. Things are perceived, and perception requires a stimulus to be present to help create it. A thought or an idea can be created without the aid of an immediate stimulus. You can open your eyes and see a book, or you can close them and think of a book. Your thought of the book somehow duplicates your perception of it. Your symbolic substitute for the book may not duplicate it exactly, but it will often serve your purposes.

The old saying, "Out of sight, out of mind," is not strictly true, at least of human beings. We react to objects not present because we carry with us something that stands for them. That which stands for the absent object we often call an idea, or an image. In more general terms, it is a *symbol.* A symbol is anything that stands for something else. We react to it in much the same way as we do to the thing itself. *Thinking is symbolic behavior, for all thinking deals with substitutes for things.*

In this chapter we shall examine the various kinds of symbols, and, in the two chapters to follow, we shall see how symbols are used in solving problems, and in the process of invention.

The Symbolic Level. Fig. 18.1 shows very roughly the relation of symbolic behavior to ordinary behavior. In activity at the lower level (see Fig. 18.1), nervous impulses enter the brain, arouse perceptions, and after being directed into the appropriate motor neurones, they exit into certain effectors and produce a muscular or glandular response. The sequence of activity is stimulation—perception—action, in rapid succession.

We may think of the symbolic level of behavior as being superimposed upon this. Action of effectors is inhibited to some extent while this level gets in its work. The thinking level duplicates in symbolic form the kinds of adjustment that take place at the lower level. Reactions can be tried out and accepted or rejected at this

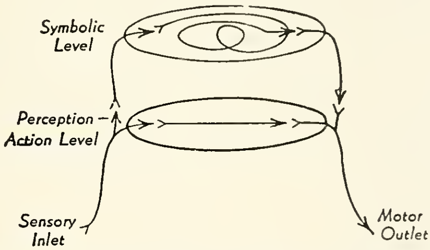

FIGURE 18.1. A diagram to illustrate the symbolic level of activity as superimposed upon the perception-action level.

level without exerting the usual gross muscular effort that would be required at the lower level, and without the risk of fatal consequences. If we were to try out *every* muscular action that is suggested by a situation, think of the many useless movements we would make, the amount of useless energy we would expend, and how disastrous some of our responses would be. When trial-and-error behavior can be carried out on the symbolic level, in advance, we are spared all this wastefulness. The result of thinking is economy of time and effort, and greater chances for survival.

Delayed Reactions and Muscular Sets

The most rudimentary form of symbolic behavior is seen in the delayed-reaction experiment. This experiment, first attempted with rats, was later tried with dogs, raccoons, cats,

monkeys, apes, and children. In its original form, it is conducted as follows.

The Delayed-Reaction Experiment. An apparatus provides three food boxes in plain sight of the animal. Over one of them is a light signal to which the animal has already been trained to go to obtain food. Until training is completed, he is allowed to go immediately to the box with the signal over it. This signal is changed to other boxes in haphazard order in different trials. Then come the test series. The animal is now restrained behind a glass barrier while the light signal is turned on above one of the boxes. The light is then turned off, and the animal must wait a short time before he is released to go to the food box. To reach the food, he must "keep in mind" which box is the correct one. The light is no longer there as a stimulus. The boxes differ only in position. If he goes to the correct one consistently, it is because he carries something within himself which makes one box different from all the rest. What does he carry over during the waiting period? It is not a satisfactory answer to say simply that he carries over a "memory" of the light.

Early observations in this experiment showed that subjects were most likely to be successful if they could keep their bodily posture oriented toward the lighted box. This suggested the theory that what the rat carries over from the light to the response some seconds later is a *muscular set*. When the light is above one box, the animal adjusts himself to run in its direction. The muscular set is a pattern that he can revive when he is later permitted to make a choice. The set is a response to the situation, which remains after the light is gone. There is no good reason to believe that the rat has a visual image of the light over the box. Not all human individuals would say that they have such an image. Were we in the rat's place, we would probably say that we felt something pulling us in the direction of the correct box. In addition, we might have verbal associations connected with it, which, of course, the rat cannot have.

The Time of Delay in Different Species. It is of some interest to compare the records of the different subjects used in this experiment. Hunter, who originated it, gives the following times: [1]

Rats	1-5 sec.	Child, 1 yr. 3 mos.	20 sec.
Raccoons	10-15 sec.	Child, 2 yr. 6 mos.	50 sec.
Cats	16-18 sec.	Child, 5 yrs.	at least 20 min.
Dogs	1-3 min.	Gorilla	2-3 hrs.

Later tests have shown that such delays may be very much longer. The early experiments gave the subject his test trials in quick succession. This plan probably led to confusion of sets, and so it caused errors. Without such confusion, rats have been known to delay their reactions successfully as long as 45 seconds, cats for several hours, and apes as long as a week.[2] Infants of 20 months have delayed responses up to 15 minutes, and preschool children for a matter of days.[3]

Very much depends upon the conditions. If the subject sees food or candy placed inside one of two containers that differ in position, in size, or in color, that is one thing. If he sees it buried in a certain spot in the ground or hidden in a certain corner of a room, that is something else. In any case, the successful subject behaves as if the sight of the container or the location suggests something that is out of sight, and yet to which he is reacting The goal object being hidden, it cannot serve as a stimulus. Something inside the individual that he has carried over from the time when he saw the object hidden must be responsible for his reaction. The thing carried over we may call a symbol, and one kind of symbol is a muscular set.

Images

Another kind of symbol is the image. Images are reproductions of previous perceptions, usually in weaker and less complete form. As you sit down to relax after your evening meal, or as you sink into your pillow for a night's rest, you are likely to think over the day's experiences. The situations that you enjoyed, and the ones that may have troubled you are gone. But they come back to you, either because you intentionally review them, or because they flock in upon you without your intention to have them. Only in very rare cases are images so complete or so strong as to equal the original perception. But they are undeniable in their vividness for some people, and they must be reckoned with as a kind of mental activity.

Types of Images. Images can come back to us in any form in which things were originally experienced. Not all images are visual, although this is the most conspicuous kind in most people. They may be auditory, tactual, thermal, olfactory, or gustatory, or even of kinesthesis and of pain. They often come back in combinations. You may see and hear a barking dog and feel his woolly hair in your grasping fingers. After bathing in the surf at the beach, you may visualize the rolling waves, hear the roar and splash of the breakers, feel the pressure of water and the strains in your body as you are swept off your feet, and taste the salt of the spray in your mouth. Descriptive poetry and prose that arouse rich and vivid imagery are highly appreciated. For some readers, they are almost as good as living through the actual experiences.

The Eidetic Image. Some individuals, almost always children, have the power to revive a former perception very fully and completely. Having inspected a picture of a street scene, they can later see the same scene projected upon a blank screen. Most people, when asked to describe a scene from memory, can relate only those facts that they took pains to observe when they perceived the scene. Eidetic individuals can observe new facts not noticed before by inspecting their eidetic images. Most people could not tell you how many pillars there are on the front of a building that they enter every day of the week, unless they had stopped some time to count them and remember the number. Eidetics could call up an image of pillars they have seen and count them in the picture they create. Eidetic images may also occur in senses other than vision.

In groups of children aged 6 to 12, as many as half of them are sometimes found to be eidetic. Somehow, at puberty, this power is lost. It may be merely outgrown or replaced by other ways of thinking, or it may be actually suppressed. Occasionally a person retains the power through adult life. There seems to be no correlation between the eidetic power and general intelligence. Some eidetic adults have been found to show artistic inclinations, but when some 20 sculptors and painters were tested, none was markedly eidetic. All of them, however, had very good memory images.[4]

The Use of Images. Studies of people and how they think, have shown that images are not quite so essential as was formerly believed. Galton found that, although children have a rich equipment of imagery, adults, especially those engaged in intellectual pursuits, reported very little use of images. Some even denied that they had any at all, though in this they were probably thinking of visual imagery only. Some people who are very successful in occupations that you would expect to depend upon images, say they do not use them. For example, a painter may have little visual imagery and a composer little auditory imagery. Such people undoubtedly substitute other kinds of symbols, either muscular sets or verbal thoughts, for images. Or they may substitute kinesthetic images for visual or auditory ones.

Individual Differences in Thinking. Again we see that the organism does not use all its resources. Where one person succeeds by using images, another succeeds by using other kinds of symbols. For abstract thinking, as in mathematics, images may be too cumbersome. Thinking in philosophy or in politics may proceed in more facile manner if done in terms of words than if conducted in the form of images. We also see why it is often difficult for one person to explain his conceptions to another. The two may not think in terms of the same kind of imagery or the same kind of symbol. Sometimes you can tell by reading an author's writings whether he is a visualizer or a kinesthetic thinker, or whether he is particularly poor in imagery of any kind. If you cannot bring to bear on your reading some of his same mode of thinking, you are likely not to understand him so well.

Concepts

Another kind of symbol is the concept. It is the thing that you carry away as a result of experiencing a *class* of objects; a something that they have in common which makes you treat them as equivalent. You meet individual cats, but in all of them you identify something that can be called "catness," in spite of variations in color, size, length of hair, or length of tail. This common pattern is your concept of cat. Two processes are

important in the formation of any concept: (1) abstraction and (2) generalization.

Abstraction. Abstraction means the isolation of single properties or aspects of anything. It is an analytical process. In forming a concept of a class of things, the common properties must be isolated and identified, either consciously or unconsciously, and the irrelevant properties, that change from one member of the class to another, must be ignored. In its lowest and most elementary form, a concept simply means that the organism reacts in a similar manner to similar stimuli. Objects of a class may be so much alike because their common properties far outnumber their differing ones. The organism then simply fails to discriminate

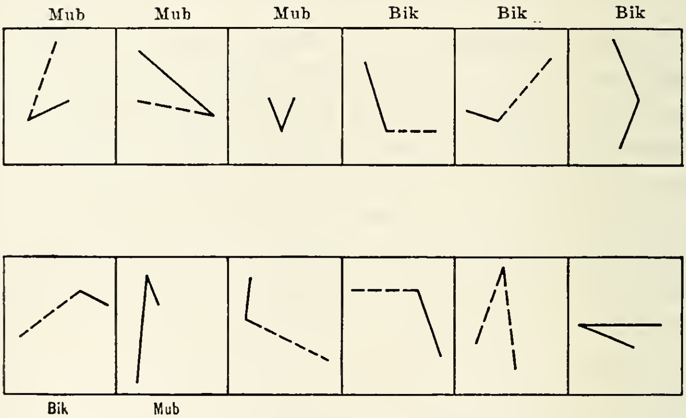

FIGURE 18.2. Figures belonging to two classes or concepts, Mub and Bik. Can you name the remaining figures in the second row?

between them. At the highest extreme, in the typical human concept, we attach a word or other symbol to it, we recognize that there is a class and we may in addition, give it a logical definition. Between the two extremes lie many degrees of awareness of classes and their essential properties.

A simple example of abstraction is shown in Fig. 18.2 Here two classes of objects are shown, one labeled with the nonsense word, *"Mub,"* and the other with *"Bik."* Three examples of each one are given. In the second row are additional specimens of both *Mub* and *Bik*. The average student will very readily see that

the common element of the *Mub* is its acute angle, whether the lines are long or short, dotted or solid. The common element of the *Bik* is its obtuse angle. The new specimens of the second row are then easily identified.

Abstraction in Lower Animals. The process of abstraction is not by any means a strictly human process, for it is also found in the behavior of lower animals. Suppose that we train a rat to jump through a curtained doorway to obtain food. We confront him with two curtains, one having on it a large white triangle on a black ground and the other a small white circle on a black ground (see Fig. 18.3). He is given food when choosing the triangle, until he learns to make the right choice every time. He can learn to discriminate the doorways either on the basis of size or on the basis of form, or both.[5]

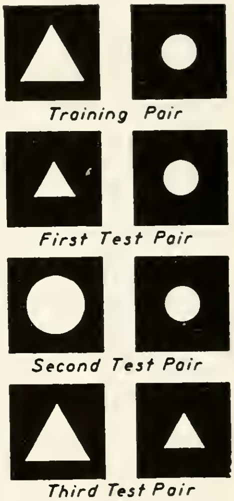

FIGURE 18.3. Patterns used in studying the process of abstraction in rats. Rats taught to jump through a curtain having on it the large triangle and to avoid the one having the small circle, are later tested with other pairs to see whether they have learned to discriminate the figures on the basis of size or of form or both (see the jumping-discrimination apparatus in Fig. 1.2).

Tests will show which particular discrimination he has actually learned. One test consists in giving him two spots the same size, one a triangle and the other a circle. If he fails to enter either door or enters either one indiscriminately, we conclude that he was depending upon a difference in size. If he enters the triangle and not the circle, we conclude that he discriminated on the basis of form. Another test would be to give him two triangles of unequal size or two circles of unequal size. If he consistently chooses the larger of the two, he is reacting to the property of size. If he avoids both circles and responds to either of the two triangles indiscriminately, he has abstracted form as the significant cue. Almost always the rat singles out one aspect as his basis of discrimination, color, brightness, size, form, or pattern, and he clings to this way of discriminating until given

a thorough re-education. In singling out one aspect, he is making an abstraction.

Generalization. Having abstracted some property of a thing, we almost automatically extend that property to all members of its class. We expect to find this property in all future members of the class. The most rudimentary form of generalization we found in connection with the conditioned response (see Ch. XIV). The child who is bitten by a dog expects biting as something essential to all dogs, until exceptions occur. In this way, irrelevant properties may cling to objects of a class for a long time. From the experiences gained from the designs in Fig. 18.2, we should expect all future *Mub's* to have simple acute angles, and all future *Bik's* to have simple oblique angles.

Generalization and Prediction. Generalization is the basis of all prediction. There would be no profiting by experience if we could not generalize and respond to new stimuli as we have learned to respond to similar ones in the past. There would be little consistency in behavior if it were not for generalization. Some generalizations are kept in a plastic condition, like a hypothesis, subject to revisions. Other generalizations become rigid and fixed, with repeated verifications, even though they may prove eventually to be wrong. Science works for generalizations in the form of classifications and general laws that can be shared with others.

Concepts Change. Enough has been said to show that a concept is not an absolutely fixed and static entity. It is usually a growing, changing mental structure. We often find our first generalizations wrong, and so are forced to modify them. This is true of each individual, and it is true of a civilized society in which most concepts are shared. Your concept of "man" changes almost with each new experience you have with new people. Your concept of "thinking" should be modified a number of times during the reading of this chapter. Humanity clung to the concept of a flat, nonmoving earth until masses of contrary observations changed matters.

Factors in the Learning of Concepts. The greater part of our education, particularly our school education, is a matter of

learning new concepts. This being true, it is important for those who act in any way as teachers to know the most efficient ways of teaching concepts to others. Essentially, there are three ways of doing this.

The Inductive Method. One is the *inductive* approach, in which a number of concrete examples are shown, allowing the pupil to build up his concept in the natural, everyday manner. Nothing more is done for him except to make sure that he meets the individual cases or examples. Simple examples, with as few irrelevant elements as possible, are by far the best. If there are both simple and complex examples, it is better to begin with the simple ones. The learning of concepts, like other learning, involves both trial and error, and insight. Many errors may be made at first that are eliminated later. The essential nature of the concept may come as a flash of insight, or as a succession of insights.

The Deductive Method. The *deductive* method begins by giving the pupil an idea of the common properties of the objects of a class, by means of a drawing, a verbal description, or a formal definition. The individual must be able to identify the particular members of the class later. Told that a noun is always the name of something, the child can choose or reject words given as examples of nouns, if he understands the definition. Much teaching is done in this way, alone. If the individual already has a good working vocabulary, a description or a formal definition may suffice. The results with this method are quite variable, and when it is used alone, many wrong impressions are often left.

The Mixed Method. Best of all is some mixture of both inductive and deductive procedures. When presenting examples, call attention to the essential elements. After defining, give examples and show the significant properties in their natural settings. The showing of negative cases, that is, concrete examples *not* belonging in the class under discussion, is rarely of much value, unless discrimination between one concept and another is difficult to make. The first method, that is, induction alone, may leave the subject with the concept but unable to formulate it in words. The second method, deduction alone, may give him a verbal formulation

without a real appreciation of its meaning. Textbook definitions too often have this unfortunate outcome.

Language

Language provides perhaps the most common, and decidedly the most useful, kind of symbol in human behavior. Verbal symbols carry most of the burden of modern thinking. They are in the form that is most readily communicated to others. Verbal thinking always has a social reference, directly or indirectly.

Much of our thinking is really in the form of talking to ourselves. As Watson very neatly expressed it, thinking is "subvocal talking." We can subscribe to this statement, provided it does not mean that *all* thinking is subvocal talking, for we have seen that some thinking may be in the form of images, some in the form of muscular sets, and some in the form of unverbalized concepts. Careful observation shows that the vocal organs, including the tongue and the larynx, undergo very slight muscular contractions while a person is thinking. When thinking becomes difficult, the speech movements are more vigorous, and it is probably true that they help emphasize the symbols used in thinking. But it has never been shown that thinking cannot go on without muscular contraction, especially contraction in the organs of speech. This point is rather hard to settle with certainty for lack of decisive information. It is the author's view that the final goal of thinking is to be free of the use of *all* muscular contraction in the process. When nonmuscular thinking is hard-going, we are more likely to resort to muscular aids.

The Origin of Language. Although man is often pointed out as the talking animal, speech is not confined to him alone. We find vocal cords in many lower animals, and they are used in giving calls and cries that serve as a means of communication between individuals. The most common animal cries have to do with the elemental motives of fear, hunger, and sex. There are characteristic warning cries, food cries, and mating calls. A warning cry causes other individuals to escape, although they themselves have sensed no danger. The baying of a hound or the pursuit cry of a

dog that is chasing its quarry, calls others into the chase. The young have a hunger cry, which affects the mother, who pays attention to their needs. In every case, the call refers to something out of sight; an enemy, food, or an inner craving, and other members of the group who are within hearing react accordingly.

There are also a few symbolic *gestures* in the language of lower animals. A rabbit senses an enemy and beats the ground with his feet. The thumping sound serves as the cue for others to dive for shelter. Human language is much richer in gestures than is that of lower animals, but the vocal mode of expression has far outstripped the more cumbersome forms. The reasons are obvious. Gestures cannot be seen in the dark or around corners. The use of the vocal organs frees the rest of the body for other necessary activity at the moment.

Development of Language in the Child. Books have been written on the subject of how language develops in the child, but we can only trace the bare outlines of that development here. Five stages may be mentioned.

(1) *The Reflex Stage.* From the very start the newborn child has the power to make certain vocal sounds. The vowel sounds come first, beginning with "a." Then come "m," "p," and "b," followed later by others. The fact that the infant has no teeth eliminates the possibility of making all the speech sounds very early. He learns to use his crying apparatus on different occasions because it gets results, but there is probably no conception on his part of crying as a means of communication.

(2) *The "Echo-Babble" Stage.* In this stage the infant does much repeating of syllables and much imitating. There is opportunity at this time for him to learn to imitate by conditioning. He naturally repeats the same syllable over and over, for example, "Da, da, da, da, . . ." Every time he utters "da" it stimulates his ears just preceding the next vocal response, "da." Now he is ready to say "da" the moment he hears anyone else utter it.

In addition to this learned type of imitation, there may be an inborn mechanism for vocalizing a speech pattern just heard. Such a mechanism is apparently found in parrots, magpies, and some other birds, and thus it could occur in human infants. Some

ability to imitate sound patterns never made before seems almost necessary to assume. Children may hear a new word, which they repeat with surprising accuracy an hour or so later, without intervening practice. There are a few observations of children who did not talk until past the age of two and who then suddenly began. They even talked in complete sentences. This does not mean that there is always a perfect imitation of sound patterns. Much trial-and-error learning, with self-criticism and self-correction, takes place.

(3) *Sounds Become Meaningful.* The next step is to attach the sound to an object. The first word attached to a familiar object comes at about the age of 10 to 12 months. This acquisition has all the marks of a conditioned response. At the moment the child reaches his hand out to touch a pet cat, his watchful mother says "kitty." Having already gained the power to repeat words, the child immediately utters "kitty." The visual object (cat), the center of his attention, immediately precedes his vocal response, "kitty." Perhaps no further repetitions are needed for him to vocalize "kitty" merely at the sight of the cat and *without* hearing the word uttered. A rather clear case of conditioning has taken place.

In another example, it is easy to see how the child learns to obey commands. As he leans over to pick up a ball, his approving mother says, "Yes, pick up the ball." After a very few repetitions the sound of "pick up the ball" is sufficient stimulus to make the child reach for it. The reaction may transfer to other objects besides balls. An abstraction has taken place and the meaning of "pick up" has been learned.

(4) *The Awareness of Language.* The phenomenon of insight enters the picture next. The child begins to realize that words stand for objects, and by employing them he can obtain results. When he uses words to stand for absent objects, we can say that he has begun to acquire language as a tool of human communication. At about the age of 18 months we find the typical child using single-word sentences. A lone word for him means a whole sentence. His utterance, "Milk," may mean "I am hungry," or "I want some milk." The single word, "Baby," means

for him, "That thing belongs to me." Shortly after this stage, he puts two or more words together to form short sentences. Later he begins asking questions, and by the age of three he is quite a conversationalist. All through this development, the average girl is in advance of the average boy of the same age.

(5) *Reading and Writing.* The use of graphic language, both for expressing one's self and for apprehending another's message, comes later in the child as it came later in the human race. We begin to teach the average child to read at the age of six, and to write a year or two later. The subject of reading has been mentioned on one or two previous occasions. Learning to write is a matter of acquiring skill in the use of some rather fine muscular patterns.

The Growth of Vocabulary. The size of the reading vocabulary is a good indicator of the general mental growth of an individual. One's vocabulary grows in proportion to one's education, but it also grows in proportion to one's inborn powers to acquire verbal ideas. Of the 400,000 different words to be found in recent unabridged English dictionaries, how many does the average person know? Naturally, the size of the vocabulary increases with age. Individuals of all ages, from 8 months to the age of college graduates, have been tested for the size of vocabulary. It is impossible, of course, to ask a person whether he knows the meaning of each one of the 400,000 words. A representative sample of 100 or 200 words is used. If he knows a certain percentage of these, his total vocabulary is then estimated on this basis. The total vocabularies of very young children can, of course, be directly counted.

The results of two extensive studies were used to construct the growth curve in Fig. 18.4 [6]. One study carried the estimates up to 6 years, and the other from 8 to 18 years, or from grade II to grade XII. These tests were based upon school children's responses, and do not take into account those duller children who dropped out of school in the higher grades. If we were also to consider those who dropped out of school, the upper part of the curve would have leveled off farther below 20,000 words than it did. It will be noticed, however, that the curve is continuous, and

that there is an increase of rate of learning vocabulary during the first 12 years, and a slowing down in rate as age 14 is passed.

The curve for acquisition of vocabulary reaches its peak between ages 20 and 25, and then remains at the same level, with only a slight decline to age 50 and beyond. It must be remembered that we are talking about averages of groups of individuals here and not of any one particular individual or of the same group, followed through different ages. An educated person's curve for vocabulary might keep on rising to age 60, and has been known to do so. Another person's curve might begin to decline after

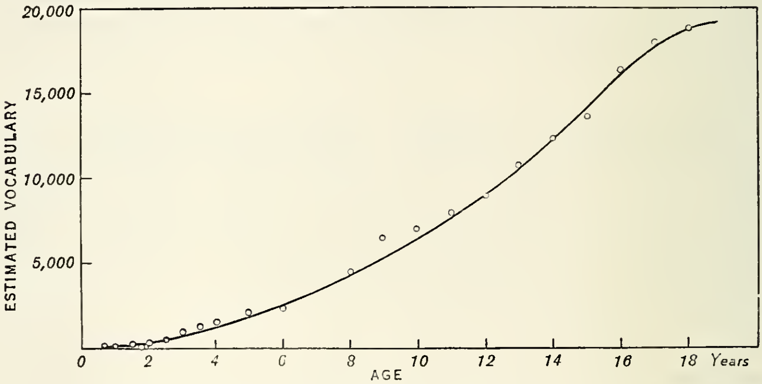

FIGURE 18.4. The typical growth curve for development of vocabulary from 9 months to 18 years.

quitting school at grade VIII. The curve in Fig. 18.4 stands for the typical individual, with whom others can be compared.

SUMMARY

Thinking is a general term that includes all symbolic activity. Symbols stand for things or conditions. In thinking we manipulate substitutes for real objects, situations, and events. It is as if we had two levels of stimulus-response: the perception-action level, in which stimulation, perception, and motor adjustment follow in quick sequence; and the symbolic level, in which the situation and possible adjustments to it can be represented in substitute form while actual motor adjustments are held in abeyance.

Symbols, or in more common terms, ideas, can be had in a number of forms. They may be in the form of images, muscular sets, concepts, or in the form of verbal responses. These forms are actually used in all sorts of combinations.

A concept is an idea standing for a class of things. In forming a concept certain common properties of the class must be abstracted from the extraneous matter experienced in members of the class. The common properties are generalized, leading us to expect them in all future members of the class. Predictions thus depend upon generalization. Even lower animals have the power of forming certain concepts. Concepts may be taught by induction or by deduction, but usually a mixture of the two methods is best.

Language developed as signals in connection with the most vital needs of animals; in their cries connected with fear, hunger, and mating. The human child, in his development, goes through several noticeable stages, involving all varieties of learning, in learning to use language. The growth of a child's vocabulary, in a rather uniform social environment, parallels very closely his growth in intelligence or general mental power.

Questions

1. It may be said that some thinking is sensory and some is motor. Explain, giving examples.

2. What kinds of symbols mentioned in this chapter might come under the heading of *imageless thoughts?* Explain.

3. What relations may exist, sometimes between images and concepts? Images and language?

4. Describe briefly some example of eidetic image you have found.

5. Can the processes of abstraction and generalization ever occur separately? Explain

6. Make up some lists of objects to illustrate the same facts as do the objects in Fig. 18.2, but involving new common elements and new names. Apply them as stimuli to a number of subjects. Report your results and conclusions.

7. Explain in some detail how you would teach the concept of "vertical" to some children who do not know the meaning of the word. Tell wherein you use induction or deduction, or both.

8. Cite evidence for and against the theory that all human thinking is in the form of language responses.

9. Do the same for the theory that all thinking is muscular response.

10. Can a person's level of education be measured by the size of his reading vocabulary? Explain.

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CHAPTER XIX

Reasoning

THE TERMS "thinking" and "reasoning" are often confused in common use, being employed almost interchangeably. "Thinking," however, is the general term including all varieties of symbolic activity, whereas "reasoning" is only one form of thinking. Other varieties were mentioned in the preceding chapter, including imagery and concept formation. Still another variety, inventing, has been reserved for the chapter to follow.

The Nature of Reasoning

Reasoning Is Symbolic Problem Solving. Reasoning is best defined as problem solving in the form of symbolic activity. A problem is any lack of adjustment with which an organism is faced. Some problems are solved on the perception-action level (see p. 423). This type of solution comes under the heading of overt trial-and-error learning. Insight plays a role in this type of solution when the situation is simple enough for the organism to perceive new relationships that are useful. In this type of solution, concrete objects are present, and they are manipulated by muscular activity.

In reasoning, we manipulate symbols, instead, and muscular activity is reduced to a minimum. Many things that go on in the

process of learning at the perception-action level are duplicated at the symbolic level. Reasoning involves trial and error, and also insight. Reasoning is therefore a variety of learning. After reasoning, the organism is left with new patterns of response in the face of situations where he had none before, or where he had different ones before. But in reasoning, as contrasted with trial-and-error learning, one's past experiences play a much greater role. Previous experiences are recalled and organized into patterns that did not exist before. Thus, while there are many things in common between trial-and-error learning and reasoning, there are enough new aspects to justify us in making a study of reasoning for its own sake.

Common Motives for Reasoning. Reasoning is always initiated by a problem; but there are many kinds of problems. One thinks first of the distinction between practical and theoretical problems. Practical problems are met every day and on every hand. You leave home in your car to make an eight o'clock class and, after going two blocks, a tire goes flat. You have an examination that you cannot afford to miss. It is too far to walk and no bus is in sight. What can you do? Here is a homely, practical problem.

Let us assume that you solved this problem somehow and reached your class in time for your important examination. In the examination, which, let us say, is in sociology, you are asked why the children of foreign-born parents are more likely to become delinquent or criminal than are children of native-born parents. You have not seen any answer to this question, so far as you can remember, but you think of some psychological facts you learned in connection with your psychological study of motives that seem to explain the matter, and you believe that you have the answer. You have solved a theoretical problem, at least to your own satisfaction.

The motives behind the effort to solve practical problems are as varied as the problems themselves. Any maladjustment implies an ungratified motive of some kind. The motive behind a theoretical problem is primarily that of curiosity. This type of problem starts with the question "Why?" Curiosity, as was said before,

urges us to gain knowledge in advance of its usefulness. We are uncomfortable until curiosity is allayed, in spite of the fact that the finding of an answer leads to no immediate practical goal. Scientists have an unusual amount of this urge of curiosity, which finds few questions too trivial to merit attention. The outcome will, at some time, probably prove to be of human value.

A Typical Example of Reasoning. Before we try to see what the essential steps in reasoning are, let us examine a suitable example. Suppose you are motoring with friends to a neighboring city for an evening's party. Midway to your destination the motor of your car suddenly sputters and dies. What can be the trouble? Your first thought concerns the supply of gasoline. Your gasoline gauge is not working, but you remember that you had filled the tank yesterday and had not driven the car far since then. This idea about a lack of gasoline is your first hypothesis as to the source of the trouble. Your rejection of the idea because it is inconsistent with other facts, was made entirely on the symbolic level. The whole sequence of ideas may have taken only a fraction of a second.

Your second hypothesis is that the ignition has failed, for ignition and fuel are the two most important elements for the running of a gasoline motor. You have learned in the past how to test the ignition, and you proceed to do so. Here you resort to the perception-action level to test your hypothesis. You find that the ignition seems in good condition. Your next hypothesis is that there is a clogged gas line to the carburetor, for a friend of yours had told of having that trouble. Your test of this shows that the gas line is clear, but that there is no gasoline in it. This fact leads you to re-examine your first hypothesis that the gas tank is empty. You think in quick succession of things that could have happened to your fuel supply. Thieves could have drained your tank. But why did they not take it all, and how could they have entered your garage which is guarded by a police dog? This is another case of checking of a hypothesis on the symbolic level. You examine the tank and find it actually empty. A new question arises: how did you lose your gasoline? The cap is on tight, so a careless filling-station attendant is not to blame. Could there be a hole in

the tank? Then you remember running over an object in the road a few miles back that gave a sharp thumping sound as you passed over it. You probably would never have recalled this fact as long as you lived if it had not fitted into the picture so neatly. A closer examination of the tank shows a small hole in it, resulting in a slow leak. All the facts, perceived and recalled, fit together very much as do the parts of a jigsaw puzzle.

But your main problem is not yet solved. How can you proceed to your destination? Again, one solution after another occurs to you: signal for a lift to the next town; walk to the nearest farmhouse and telephone for help; mend the leak in the tank with chewing gum, and get a small supply of gasoline from the nearest farmhouse or filling station. Past experiences help to suggest the solutions. The entire set of present circumstances also forces you to think of certain possible solutions. Both past experience and present circumstances work to select and to reject some solutions before they are actually tried out. Each possible solution can be tested on the symbolic level, or it may be tried out in practice. In either case, if it fails to measure up to expectations, you are thrown back upon the search for further solutions. The trial-and-error nature of reasoning is thus very apparent. Sudden, happy thoughts come in the nature of insights. They emerge suddenly like the hidden face in a puzzle picture, or like a new relationship perceived while learning to master a situation by overt trial and error.

Making an Inference. The thing that is most novel about reasoning is the drawing of a conclusion from known items of experience. This process is called *inference.* An inference is a new item of knowledge that is deduced from other knowledge. The known items may be perceived or they may be recalled in symbolic form. The inferred item is always in symbolic form. You glance out of the window and see puddles of water standing on the pavement and the sky is overcast. Although you see no rain falling and heard none, you feel confident of your conclusion that it has just been raining. You hear a siren sounding down the street and see a thin stream of smoke rising over the trees. You identify the event as a fire truck dashing to a fire, rather than

as an ambulance rushing to an accident. Drawing an inference consists of "putting two and two together," to use a very familiar expression.

The two examples just given are inferences made from perceived items. Examples of deductions, or inferences made from symbolic facts, can be found in the preceding illustration of the entire reasoning process. The first conclusion that the gasoline tank could not be empty was drawn from the recalled fact of having filled the tank the day before, and the fact of not having driven since that time. The conclusion that the tank was not drained by thieves was drawn from the recalled fact of the police-dog guardian, and the fact that the tank was not entirely empty.

A conclusion is regarded as correct when it agrees with the real or true facts. It is regarded as valid when it follows logically from the known propositions. From a psychological point of view, a conclusion need not be either valid or correct in order to be called an inference. It is an inference, none the less, and it is governed by the same laws as is a correct conclusion. Invalid and incorrect conclusions are usually caused by insufficient data, by faulty definition of data, or by interfering motives which distort the pattern. Of this more will be said later.

The Importance of Past Experience. Too much cannot be said for the importance of past experience in reasoning. Past experience furnishes the vast majority of the material with which we think. It would not be necessary to stress this fact, perhaps, were it not for the tendency of some present-day educators to disparage the pursuit of knowledge. They often insist that learning facts is a waste of time, if not actually harmful, and that the best kind of education is to train the pupil or the student how to think. But no one can think in a vacuum! One has to think about something. And if one has not a ready stock of information on many subjects, he lacks the essential materials with which to think.

Reasoning Impossible without Some Past Experience. This does not mean that memorizing facts by rote is desirable; the discussion of memory should have made this clear. But it does emphasize the value of gathering information for its use in later reasoning. Too many individuals, told they are educated to be

thinkers, proceed to reason about subjects concerning which they know very little. They either make sorry pictures of themselves or else, what is worse, they lead followers into error. The antidote, of course, is a healthier regard for facts. Facts cannot be manufactured by thinking alone. There must be a continual returning to the environment to check up on ourselves. This is another virtue of science; it abides by the verdict of experimental facts in preference to rational conclusions, when the two do happen to disagree.

Past Experience Alone Not Sufficient. We can turn to some experimental facts on the role of past experience in reasoning, for there have been experiments on this point. Billings gave 146 students a special drill on some necessary information in the fields of geometry, arithmetic, physics, mechanics, economics, geography, sociology, and history.[1] He later gave them problems for reasoning that depended upon the information they learned, and also a test on the fund of information remembered.

All such studies show that to remember the facts is one thing, and to use them in reasoning is another. This study showed that ability to reason in one subject was very highly correlated with ability to reason in another. That is, the persons tended to fall in the same rank order for reasoning scores in all the fields. The correlation between the scores on the information tests, which measured the number of facts remembered, and the scores on the reasoning tests, was not quite so high, but there was much agreement. This was true in spite of the fact that nearly all the facts were remembered by all the subjects. Those who solved the most problems knew the most material, but not all of those who knew the material could solve the problems. Knowledge of facts is therefore an essential factor for reasoning, but it is not sufficient in itself to produce reasoning. Ability to reason must also be present.

Information Determines Conclusions. There is another interesting effect of past experience, in that the conclusion to which a person comes depends upon which particular facts he has at his command. Two people often draw different conclusions about the same question, because they do not have the same facts in

their mental equipment. A short, humorous story illustrates divergent inferences because of lack of common information.

Little Girl: "Mother, where do silk stockings come from?"
Mother: "From worms, my dear."
Little Girl: "Now, Mother, don't call Daddy a worm."

The mother's background contains the information about silkworms, which she undoubtedly meant by her reply. The little girl, lacking that fact, but knowing that husbands often buy stockings for wives, makes the unintended inference.

From this sort of example we get the suggestion that if two people have exactly the same information on a subject, and if they have in addition equal ability to reason, they will very likely come to the same conclusions. The moral of this is that in trying to convince others that your conclusions are correct, see to it that they get the same information that you possess. Imparting a little information goes much farther in an argument than flat contradictions and violent assertions.

How Hypotheses Are Formed. There is no reasoning unless items of information are brought into new relationships. New patterns must be grasped before we can say that an inference has been drawn. This brings us to the question of how items of past experience are drawn into new organizations, and how hypotheses arise.

From the psychologist's point of view, hypotheses are inferences that are held tentatively while further tests are made of them. What is said here concerning hypotheses also applies to inferences in general. As in the case of perception, where we needed laws to account for the grouping of sensory material into useful and meaningful patterns, so in the case of reasoning, we need laws to explain the formation of new patterns of ideas.

Free Association. Thinking of a hypothesis is much like the simple recall of a past experience, and yet there is an important difference. In simple recall, there is a stimulus that was associated with the recalled item, which acts as a cue. The word-association test is a good example. In this test the subject is told to respond with a single word as quickly as possible when a stimulus word

is given. Note your own first verbal responses to each of these words: table—dark—butter—blossom. A list of 100 such words was given to a thousand normal adults, and the frequency with which every response came was determined. For each of the four stimulus words just given, the three most frequent responses, and one much less popular response, and their frequencies, were as follows:

TABLE		DARK		BUTTER		BLOSSOM	
chair	267	light	427	bread	206	flower	467
wood	76	night	221	milk	101	apple	50
furniture	75	black	76	yellow	80	tree	40
food	29	afraid	6	fat	21	rose	17

The Laws of Association. In the free-association test there is a minimum amount of direction or control of the response from the subject's motives or moods. To say that there is no control whatever would not be true. The free-association response is only relatively free of control. Every person has learned a number of other words in connection with each stimulus word, at some time or other. Which word will come as the response depends upon a number of factors. If the response is really uncontrolled by the motives and moods of the moment, the determining factor is the strength of the learned connection. This, in turn, depends upon the *frequency* of repetition of the connection, the *intensity* with which it was repeated, the *effect,* whether satisfying or dissatisfying, and the *recency* of its exercise. These are sometimes called *laws of association.* They account for the relative strengths of learned connections. They account for recall of experiences, with the usual reservation "everything else being equal."

Controlled Association. But the recall of past experiences in reasoning is also decidedly under the control of the immediate needs of the individual. He is set for the recall of something that will fit into the picture. The rest of the picture therefore exerts the determining influence. It is true that parts of the picture may recall ideas with which they were formerly associated. But *it is also true that they call up ideas never associated with themselves before in this individual.*

To illustrate the influence of mental set upon recall, the simple controlled-association test may be cited. The subject in this test may be instructed beforehand to give a verbal response that means the opposite to the stimulus word. Note your own responses to the following words when you are set to give opposites:

high cold friend stupid end hungry astute frenzy

No doubt your responses to the first three or four words were merely reinstatements of old connections learned before. But note how quickly your responses came, and how they crowded out the possibility of giving any other response that you might have given, without the set to name opposites. To the last three words you probably had to give responses never directly associated with them before. You may have recalled a number of words, as if by trial and error, rejecting each one in turn until the right one came.

As another example, set yourself to respond to each of the following words with the name of the larger class to which it belongs (an example is the association, tulip—flower):

tree elephant gold red whale sensation

Here again the set should narrow the choices of responses down to only one and the response should come quickly, except for the last two. For "whale" you may have responded with "fish" and then rejected it for "mammal" which is correct. The word "sensation" may have given trouble for a moment until you thought of "mental activity" or some similar class name. This type of relationship is known as *supraordinate* association. The reverse type, in which you are to name a member of the class signified by the stimulus word, is called a *subordinate* association. Other common relationships are the *part-whole* and the *whole-part* associations. Examples are the connections chimney—house, and tree—leaf, respectively.

How Sets Are Aroused. In these simple laboratory experiments on controlled association, the set for a certain relationship is given by the instruction of the experimenter. In everyday life there is no experimenter to instruct us; the circumstances of the

situation do that. We have to grasp from our analysis of the problem situation just what the relationships are. Given the simple problems:

$36 + 2 =$ $36 - 2 =$ $36 \times 2 =$ and $36 \div 2 =$

we respond with the numbers 38, 34, 72, and 18, respectively. The situation furnishes an unmistakable cue as to the proper set. Just seeing the numbers 36 and 2 side by side, we should be left with a free-association type of response to be made.

We must usually discover for ourselves the relation demanded. Another laboratory test illustrates this situation. It is called the mixed-relations test, in which a relation must be discovered, and then used in determining the missing word; for example,

hungry	:	food	: :	thirsty	:	________?
deer	:	fawn	: :	hen	:	________?
fish	:	water	: :	cow	:	________?

Grasping the relationship between the first two words, one is then set to react with the proper association for the third word. So, in reasoning, we take the cue from the problem or situation as to what relations are involved, and these relations in turn determine the suggestion of the hypothesis or the inference.

A simple problem in arithmetic also illustrates this point. If two pencils cost five cents, how many can be bought for thirty cents? Something is to be done with numbers; just what is to be done must be grasped before you can solve the problem. The plus and minus signs are lacking, but relations can be inferred from the statement of the problem.

Cause and Effect. There are many kinds of relationships, but perhaps the most important of all for reasoning is that of *cause and effect.* It would be hard to say just how much of our reasoning is dominated by the demands of this relationship. Certainly a very large part is controlled by it. The mastery of our environment and of ourselves is decidedly dependent upon it. The diagnosis of any difficulty requires the discovery of causes. The effects are given with the problem, although keen observation is required to notice them all and to interpret them.

Causes must be inferred by the recall of past experiences. Through experience we build up conceptions of particular cause-and-effect sequences, and we also construct general rules or laws of cause and effect. Later, when we are *set* to find a cause of a difficulty, these conceptions already learned operate so as to inhibit ideas that do not apply, as well as to facilitate the recall of useful ideas. In this way fruitful hypotheses arise. Modern science is the ultimate in the discovery of cause-and-effect relations.

Intuition. Sometimes we reach conclusions very speedily and without the usual known basis in fact to which we are accustomed. We have what we call a "hunch" that some fact is true, without being able to lay our finger on any supporting evidence. In spite of the lack of tangible basis for the conclusion, we may cling to it with the conviction that we are right. "I just feel it in my bones" is the common expression for it. Is intuition a new source of knowledge, distinct from reason? Many philosophers proclaim it as such.

Probably it is not. An *intuition,* or a hunch, is really an ordinary inference drawn from latent information of which we are at the moment unaware. The individual may be vaguely aware of some of this information, but he cannot put it into words.

An example of a hunch would be your conviction that a certain friend is going to call you by telephone this evening. There may be some real basis for this in facts that you have forgotten. You and your friend are both on a certain committee. Your work and his have both progressed to the point where communication is necessary. You have had a tentative agreement that when you reached this stage one of you will call the other. Another friend of yours this morning called to you something about the other person's work on the committee that you did not quite grasp. It has nevertheless had its effect upon you; hence your conclusion. This case is purely hypothetical, but in all probability it is typical of all intuitions. There is therefore no reason for assuming a new way of arriving at conclusions in some highly mysterious manner. aside from inference. Tradition has it that women possess greater intuitive powers than men. There are no scientific facts on this point.

Doubt and Belief

How Inferences Are Evaluated. Some inferences you accept as true and some you reject. Some conclusions are satisfying while others are not. In the former case you have a feeling of belief; in the latter a feeling of doubt. A feeling of doubt spurs us on to further reasoning, while a feeling of belief puts an end to reasoning. Similar feelings are experienced in connection with mastery of a new motor pattern, when we feel that we "have the hang of it," and when we fail to organize our movements into a suitable smooth-running pattern. The question is why some inferences are "reasonable," leading to a conviction of truth, whereas others are not.

Logical Consistency. In general terms, the criterion of an acceptable conclusion is its *logical consistency* with the known facts. It is really the matter of logical consistency that needs to be explained. Logical consistency depends upon the grasping of logical relationships. Logical relationships are forced upon us by experience.

Becoming aware of a logical relationship is the same kind of process as the formation of a concept. For example, we perceive that some persons are taller than others, and the relationship, "taller than," or the concept of height is abstracted. Later, when the two facts, "Harry is taller than Bill" and "Bill is taller than Chauncy" are given, almost immediately the inference, "Therefore Harry is taller than Chauncy," arises. Our experiences have forced this upon us as a necessary part of the concept of height.

This is but a simple example of the many laws of logical necessity that are forced upon us by experience. When we violate these laws the environment brings us back to our senses. We learn such fundamental laws as the one that an object cannot be in two places at the same moment, or that two objects cannot occupy the same position in space at the same moment. We learn Aristotle's fundamental principle of logic, that a thing cannot be both A and not -A, although the vast majority of humanity never verbalizes this principle, or, for that matter, most other principles. They simply act as if those principles apply.

Syllogistic Reasoning. In everyday life the average person does not even verbalize the facts from which he draws his conclusions, nor need he verbalize his conclusion unless he wishes to communicate it to some one else. Students who take a course in logic learn that it is possible to verbalize nearly every act of reasoning by stating in sentence form the facts and the conclusion derived from them. The facts are called the *major* and *minor premises*, and the inference is simply called the *conclusion*. The entire statement of facts and conclusion is called a *syllogism*. A typical example is the following:

> All wealthy men pay taxes. (Major premise.)
> Mr. Black is a wealthy man. (Minor premise.)
> Therefore Mr. Black pays taxes. (Conclusion.)

The study of logic is concerned with the validity of conclusions, that is, whether conclusions follow logically from the premises. It does not attempt to tell how we reason, but rather to tell whether we have made any error. An individual with a clear, logical mind can sense errors in reasoning without having studied logic, but a little acquaintance with it helps many people to avoid the more common mistakes, by putting their reasoning into syllogisms. Logic is to the process of reasoning what grammar is to the use of language. Both provide formal rules which guide us in correct usage, but neither will guarantee clear thinking or adequate expression.

Emotional Factors in Belief. We like to think that we are logical creatures. We may think that we never accept a conclusion unless it is logically consistent with other facts. But logical consistency is not the only basis for belief. Even when we have a sufficient number of facts from which to draw a valid inference, emotional factors may enter in to bring us to a false conclusion.

Uncritical Beliefs. Young children, who naturally learn to be submissive and who identify themselves emotionally with parents or teachers, come to accept with confidence the opinions of their elders. Some find their sources of beliefs rather trustworthy, so they develop a habit of looking to others for conclusions. It is easier than to resort to the labor of thinking for one's self. Such

individuals rarely develop much confidence in their own judgments and are content to take assertions on faith. They are the gullible ones. Children of lower intelligence, who find reasoning for themselves difficult and undependable, fall more readily into this class.

To some extent, all of us often rely upon authority for opinions when we recognize the superior qualification of the authority as compared with our own. No one can possibly have sufficient information in broad fields of knowledge to form reasonable opinions of his own on all subjects. It is perfectly sound practice to accept the judgments of experts in fields where we ourselves are weak. But there is a tendency to misuse that opportunity in our present civilization where specialized fields are numerous.

There is a tendency for the masses to accept the judgments of an expert in a single field when he utters opinions upon any question whatsoever. Just because a motor magnate has shown brilliance in the invention of a machine and in the manufacturing and selling of his product, he is expected to utter words of wisdom concerning such remote subjects as education, crime, and problems of government. Because a man has amassed millions in wealth he is thought to be an authority on art, music, and many other things. Again, it should be emphasized, no one can reason successfully in any field unless he has sufficient information in that field. One man's opinion in the field of finance might be the last word in brilliance; his opinion as to how to produce a movie or on how to teach a child arithmetic might be worse than worthless.

Wishful Thinking. We often believe what we wish to believe, even when we know better. Some shortsighted motive that can be gratified by arriving at a wrong conclusion frequently has its way in the face of a gross logical inconsistency. The old saying,

> "A man convinced against his will
> Is of the same opinion still,"

is profoundly true. Where the truth hurts, logic is likely to give way. A young bride loses her husband by death. She refuses to accept the obvious evidence that he really died. Even though she went through the ordeal of a funeral she maintains that he is alive, that he has gone away on a business trip, and will some day

come back. This is an extreme case, but only the kind of thing all of us do on a smaller scale every day.

Such false beliefs, held in the face of ordinarily contradictory evidence, are called *delusions*. Some individuals believe that they have many secret enemies who perpetually persecute them and cause them to fail (*delusion of persecution*). Other persons think they are really kings, queens, presidents, generals, or even God, in disguise, and they tend to act accordingly (*delusion of grandeur*). Still others believe that they have been despicable sinners and are now being punished severely and justly for their sins (*delusion of guilt, a form of melancholy delusion*). Any of these delusions is usually sufficient to diagnose the individual as insane, but many milder false beliefs are found in almost anyone. Argument is usually of no avail. People with genuine delusions hold tenaciously to them because of the motivational value the delusions have for them.

An experiment by Lund shows how belief seems dependent upon desire.[2] First he asked several hundred students to judge a list of propositions or opinions as to the certainty of their own belief or disbelief of those propositions. The propositions were like the following examples:

> Slander is morally wrong.
> The dinosaur once existed.
> Animals have feelings similar to our own.
> Two plus two equals four.
> All men should have equal political rights.

A statement which the subject believed so strongly that there was no room for doubt, he was to rate +10. A statement that he disbelieved so strongly that there was no room for doubt, he was to rate −10. Statements that he was neither inclined to believe nor to disbelieve, he was to mark with a zero.

On a later occasion Lund asked the same subjects to rate the same statements for the desirability or undesirability of their being true. Minus 10 meant the most complete undesirability, +10 the most complete desirability, and zero meant indifference. The result was a correlation of +.88 between the strength of belief and the strength of desire, when a correlation of +1.00 meant perfect

agreement. In other words, if you knew how strongly a subject desired a thing to be true in this list of opinions, you could predict rather closely how strongly he actually believed that it was true. It is possible that belief is to some extent a cause of desire in some cases. We should like two plus two always to equal four; otherwise we should have a sorry state of affairs. But it is probably more likely that many of these propositions are believed because the subjects would like to think so, for example, the proposition that "all men should have equal political rights." Our sense of justice demands this belief even if known facts might cause us to question its wisdom.

Factors Related to Reasoning

Reasoning in Children. It is frequently implied that children must reach a so-called "age of reason" before they can be expected to indulge in that high type of activity. Examples of reasoning can be found in children of four and even younger. The very common question of the three-year-old is "Why—, Why—, Why—?" This in itself shows that there is some appreciation of problems calling for reasoning and of cause-and-effect relationships. The "bright sayings" of children are usually early attempts at reasoning. They are humorous to us because of the absurd conclusions to which the child comes, usually due to his lack of information. A little girl of three had been told that beef comes from cows, bacon from pigs, veal from calves, and mutton from sheep after they were dead. A day or two later, her attention being called to some new cookies, she inquired, "Mother, what were cookies before they died?" Another little girl of five was told by her older brother, "I am thirteen months older than you are." To this she replied, "Well, I'll have to ask Mother. I don't see how you can be thirteen months older when there are only twelve months in a year." She had previously been told that she was a year younger than her brother.

Tests composed of syllogisms have been used to trace the development of reasoning powers at different ages in children. Simple syllogisms like the following one can be used with children as

young as six. Three ways of calling for the conclusion are given, each one a little easier than the one before:

Fritz is taller than Max.
Max is taller than Ernest.

(1) What can we say now?
(2) What can we say about Fritz and Ernest?
(3) Which is taller, Fritz or Ernest?

The results usually show that there is a marked spurt in the development of logical powers at about the ages of seven to eight. While there are many examples of spontaneous reasoning in children below the age of six, they rarely do well in standard tests of the syllogistic type.[3]

If there is any "age of reason" that is suddenly attained by the average child, tests fail to show it unless the noticeable spurt from ages seven to eight is chosen arbitrarily as that point. Development of reasoning powers above that age depends upon (1) the maturing ability to grasp relationships and patterns of ideas, (2) the accumulation of information, and (3) the acquiring of certain habits of thinking.

Reasoning in Lower Animals. Reasoning is not by any means confined to man, though very largely so. Lower animals can "put two and two together," and sometimes get "four" as the answer. As we should expect, such ability is most likely to appear in the higher apes. But some experiments show that it can happen even in the albino rat.[4]

Cases of supposed reasoning in lower animals must be examined very critically to make sure that there is use of symbolic activity and that relations are made involving symbols. In most everyday examples we cannot be sure that this is so. What may look like a genuine act of reasoning may turn out to be simply a learned response without the use of symbols at all. But since many lower animals have symbolic behavior, at least of the delayed-action type, and many can form concepts, it is likely that they can also relate those symbols and so indulge in reasoning.

Social Factors in Reasoning. People often engage in thinking as a cooperative pastime or venture. Deliberative bodies are

the most ready example of group thinking. Will the interstimulation among members of the group, the exchange of ideas and group discussion, lead to better conclusions in a shorter time? Or will one or two individuals dominate the thinking of the group and lead them into wrong channels?

Experimental studies show that, judged by its results, group reasoning is uniformly better than that of the average person in the group. In fact it is usually better than the best person in the group can do. The larger the group, within the limits of the small groups studied experimentally, the better the results. In one study on the solving of puzzles, individuals working alone turned in 8 per cent correct solutions, whereas the groups turned in 53 per cent correct solutions.[5] The advantages of group thinking lie in the pooling of information, and in the checking and elimination of errors. There is little danger, apparently, when logical problems are to be solved and when oratory is not a factor, that group conclusions will be inferior to individual thinking.

Training in Reasoning. Can individuals be trained to reason? Educators have proceeded on the assumption for centuries that such training is possible. The affirmative answer has thus far rested mostly on faith and on authority. So far as we know, most mental activities gain in efficiency through practice. From this we may expect that systematic habits of thinking can be acquired through practice, thus enlarging one's grasp of the mechanics of reasoning. But like most development through learning, the effects are probably more specific than general. They transfer only to similar situations. Until we have definite proof to the contrary, it is most reasonable to conclude that exercise in reasoning, in mathematics and philosophy, for example, does not make a good reasoner in general, unless he is taught in such a way, or has learned in such a way, as to obtain the maximum amount of transfer of the habits so acquired.

Summary

Reasoning is problem solving on the symbolic level. Trial and error and insight, which are more easily observed on the perception-action level, also occur on the symbolic level.

The most significant process in reasoning is the inference. An inference is a conclusion arrived at by organizing two or more previously unrelated items of experience into a new pattern. The previously unrelated items may be perceived at the moment, but are usually recalled from past experience. For successful reasoning, then, a usable store of concepts and other symbols is required.

Formerly unrelated items are forced into combination by the mental set of the moment, and this, in turn, is aroused by the particular problem to be solved. When items are forced into combination by mental sets, we speak of controlled association. Certain relationships are usually demanded by the mental sets, such as part-whole, agent-action, and cause-effect. These relationships are learned in much the same way that all concepts are learned. Intuitions are not distinct forms of thinking; they probably represent merely inferences drawn from largely unconscious or latent data or information.

The test of the acceptability of an inference is its logical consistency with the premises from which it is drawn. Our experiences with repeated and striking relationships in the world about us develop a basis for evaluating relationships that we experience in reasoning.

Emotional factors often enter in to distort the appreciation for consistent versus inconsistent conclusions. Wishful thinking is an all too common consequence.

Reasoning is found in young children, as well as in lower animals to some degree. It is shown to be uniformly better in group efforts than in individuals thinking alone. Individuals can probably be trained to reason, but the habits of thinking so developed may be more specific than general and may not always transfer to new types of problems.

Questions

1. Point out a number of similarities between overt trial-and-error behavior and reasoning. Point out some differences.

2. From the account of reasoning given in this chapter, make up a list of more or less discrete steps in the entire reasoning process (four should be sufficient). Give a single word to name each step.

3. What should be the student's attitude toward "learning facts" and "learning to think"? Discuss briefly.

4. Prepare a list of ten common words. Apply them as stimulus words in a word-association test to a number of subjects. For every response try to surmise the most probable law of association that operated—frequency, intensity, effect, or recency. Present your results and interpretations.

5. Find two or three examples of reasoning in the chapter or in any other source. State the reasoning as given, or in your own words, then state the major premise, minor premise, and the conclusion in the form of syllogism. Are the conclusions consistent with the premises? If not, check to see whether you have stated the premises correctly.

6. Find several examples of delusions from any source and classify them in any way you see fit.

7. Collect some "bright sayings" of children and show whether or not reasoning is probably involved. Why cannot we always tell whether or not there was genuine reasoning?

8. Collect some purported examples of reasoning in lower animals. Decide, if possible, whether any real reasoning took place.

9. What would be your advice to a student who is selecting courses that will give him the best training in reasoning? Give reasons.

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CHAPTER XX

Inventing

The Importance of Creative Thinking

How different the world would be if one could eliminate from it the results of human invention and construction. Suppose some miraculous cataclysm could wipe out at one stroke all the products of human thought. There would disappear from the world all cities, towns, and country homes, and even the crudest dwellings of primitive man. All means of transportation, including the ships of the air and the seas, trains and motor cars, railroads and highways, would vanish. All these things, and many more, are creations of the human brain. They were present in thought before they appeared in tangible form.

Only the Very Few Do Important Creative Thinking. It is necessary to admit that the really important creative thinking has been done by a very small percentage of the population. Although all human individuals, excepting those who are lowest in intelligence, do creative thinking, very little of it ever results in something of social importance. Once new creations are invented, the rest of us can enjoy them, even if we cannot always understand them.

The Creative People. The fields of creative work are known to every one. There are writers of various kinds—of poetry, fiction,

biography, and drama. There are creators of art, including music, paintings, and architecture; designers of clothing and of motor cars, of interior decoration and landscape gardening; and there are producers of dramatic art. In the field of science we have the great inventors of fruitful theories and of new conceptions of the world and its phenomena. Inventors and engineers construct first in symbolic form the many marvels and gadgets that the civilized peoples of the world enjoy. Bridges, irrigation systems, superdreadnaughts of the air and of the sea, skyscrapers, and streamlined trains testify to the inventive genius of the engineer. The radio, telephone, phonograph, radar, television, the cinema, and many other commonplace contrivances daily remind us of our debts to the inventor.

Creative thinking does not end with these more tangible products. The creation of a system of government, with its legal system, its tax system, and other machinery for carrying out its services, depends upon the inventive genius of many a student of human affairs. The planning of an educational system and of other social institutions requires creative thinking no less than does the invention of an engineering marvel. Wherever planning and construction of new things take place, there is creative thinking. As to which particular individuals are to become the originators, and as to the steps by which creative thinking develops, we shall find some of the answers in the following pages.

Inventing and Reasoning. The average person indulges in creative thinking in various ways. Whenever he puts together some isolated bits of experience in new combinations or patterns, we may say that creative thinking has taken place. This definition of creative thinking would include reasoning as well as inventing. In the sense that reasoning does bring into new patterns items of experience formerly separated for the individual, it is creative. Something new is produced that did not exist before for him. Both reasoning and inventing are forms of creative thinking. What, then, is the difference between the two?

The difference lies in their results. In reasoning, we are trying to arrive at some new facts. We want our conclusion to coincide with reality. In both perception and reasoning, the patterns we

create become more and more fixed, more and more rigid, as we check up on them. They represent more and more exactly, real facts or situations. Not so with the products of invention. Invention gets away from reality and produces patterns that have had no real existence. We are held down to reality when we want to make an invention work, and the parts that go into it were derived from real facts, but that is the only dependence of an invention upon reality. We find inventing sometimes intermingled with reasoning, for example, when a new invention is necessary to solve a problem.

Everyday Examples of Invention. Although most of us are not creative geniuses, inventing on a small scale is a part of the daily routine. We dream dreams and we plan plans. We are not writers or artists, designers or engineers, but we make feeble attempts at constructive efforts in those directions. We are all romanticists at heart. We playfully distort the drab and uninteresting daily routine to make of it something much more appealing to our desires. We escape not only from the humdrum and the banal in this way, but also from the disagreeable and the hurtful. If we cannot write fiction and drama, we read a novel that some one else has created for us, or attend a cinema and recreate a story that appeals to us. It takes some inventive activity, in other words, to enjoy the creative products of others, particularly artistic productions.

Dreams

We dream at night and we dream by day. The two kinds of dreams have much in common in spite of the fact that the dreams while we sleep are powerful in their realistic vividness whereas daydreams are usually not mistaken for reality and are weak in their vividness as compared with our perceptions of the moment. Daydreaming or phantasy was treated in an earlier chapter as a means of escaping from disagreeable reality. Something remains to be said about dreams that occur while we sleep.

Dreams that come in the night have always seemed so mysterious that a great many superstitions have grown up around them. Primitive people have sometimes taken them as actual

happenings. Religious people have taken them to be messages from the gods and have tried to find something prophetic in them. In modern times the psychoanalyst sometimes tries to interpret the dreams of his patient for the light they can throw upon his mental difficulties. Psychology now has a fairly good idea of how dreams come about and of just how important they are.

Dreams Are Initiated by Stimuli. The first thing of importance about dreams is that they are natural mental activities and they are set off by stimuli. While the sleeping person has made every effort, consciously or unconsciously, to shut out sensory stimulation from his brain, he never fully succeeds. An incidental sound, a flash of light, or a somesthetic stimulus may be the starter of a dream. For example, an alarm clock may set off a train of dream pictures in dramatic form that includes ringing sleigh bells, jangling church bells, or the crash of falling dishes. A hot water bottle at the feet may give rise to a dream of walking barefoot over hot lava; a sore on the head may start a dream of being scalped by Indians; sleeping between damp sheets may suggest the dream of being dragged through water. If a foot and a hand dangle over the side of the bed we may dream of hanging over the brink of an abyss. If one's head happens to slip under the pillow, there may be a dream of a rock crushing his head.

Dreams as Illusions. From these few examples we can conclude that many dreams are attempts to interpret a stimulus while we are asleep. The interpretation is highly false because the individual has no grasp of the entire situation. The perception is determined, let us say, only one per cent by stimulation and 99 per cent by contributions of the brain from past experience. That is why the interpretation is usually false. The arousal of the particular dream pictures must be accounted for by the laws of association, and by motivating factors within the individual that may be active at the time. We will return later to the question of motivation in dreams.

Some Experiments on Dreams. Most of the facts about dreams have to be gathered from people who have had them and the reports of dreams have had to wait until dreams occurred. But it is possible to bring about dreams when we want them and to control

the stimuli that initiate them. In other words, we can experiment upon dreams.

When a subject is put into the hypnotic trance he is in a state that in some respects resembles normal sleep. He can at least be told that he is sleeping, and usually is so told in order to induce the trance in the first place. The further instruction can be given, "If you should have a dream you are to tell me all about it the moment it is finished." Stimuli can then be applied, and usually within a few minutes a dream is reported. A stenographer then takes down the report verbatim and we have a permanent record.

In Table 20.1 are given parallel lists of stimuli and the dreams

TABLE 20.1.—STIMULI USED IN EXPERIMENTS ON DREAMS AND A FEW DREAM PICTURES AROUSED BY THEM *

Stimuli	*Dream Pictures*
Stroking back of the hand with cotton.	"A cow licked my hand."
	"A shaggy dog rubbed against me."
	"I was in bed in a hospital; my girl was stroking my hand."
	"I was playing with an angora cat across the street."
Asafoetida.	"I smelled a dead horse."
Pinching back of the hand.	"A rat came out of a hole in the corner and bit me."
	"I was handling some rats in the laboratory and one bit me."
Throwing a cloth over the subject's head.	"Someone tried to smother me. I was getting ready to choke."
Cold metal touched to forehead.	"It was winter time. It snowed, and I made a snow man."
The foot of the cot on which the subject lay was suddenly lowered.	"I was sliding down a long chute, feet first."
Sudden pressure on the left side of the cot.	"I was in an auto accident and fell off an 18-foot bluff."
	"I was falling, falling, down the side of a mountain."
	"I was rocking in a hammock, then seemed to be whirling, and saw tumbling weeds rolling over and over."
Pillow suddenly depressed on one side of subject's head.	"I was falling into a cellar, head first."

* From Klein.[1]

that they initiated in different individuals. It will be noticed that the dream picture in each case is a reasonable interpretation of the stimulus. Every dream was much more elaborated than the very abbreviated quotations imply. The stimulus is very neatly submerged in the entire dream picture. Sometimes it seems to the dreamer that the stimulus comes near the beginning, but very often it seems to come near the end of the dream.

In most cases the intensity or the size of the thing experienced in the dream is grossly exaggerated. It sometimes increases to very unreasonable proportions. This is probably due to a lack of other customary stimulation that would keep it within reasonable bounds. On the background of other very weak sensations and in a rather vacant conscious field, the one experience seems unusually large and intense.

Motivation of Dreams. When dreams are set off by outside stimuli, we still must account for the choice of dream picture when several might have done equally well. Freud gave us our first clue as to the solution of this problem. He pointed out that dreams are attempts to fulfill wishes which we have had to forego or to repress. His theory is not accepted in full, so there is no need of our going into it in detail. It is sufficient to give him the credit for pointing to our fundamental cravings as determining factors in dreams. Freud's theory maintains that the dreamer seeks pleasurable gratification, usually in disguised form. But we are forced to recognize that escape from danger and other unpleasant motives also express themselves in dreams.

Children's Dreams. In children's dreams we find gratification of thwarted motives in a very direct and undisguised form. Orphanage children dream of having rich and famous parents, and of becoming rich and powerful adults. But many dreams of children are decidedly unpleasant. The most frequent topics in dreams of the average child are: parents, animals, play, falling, robbers, death, relatives, the opposite sex, supernatural beings, riches, and fire. Children are predisposed to unpleasant dreams by: overexcitement, fatigue, illness, indigestion, fears, worries, anger, and quarreling. Unpleasant dreams diminish in frequency as children grow older. From ages 1 to 4 the unpleasant dreams are likely to

be about animals; from 5 to 9, of strange, bad people, war, fire, and electricity; and from 9 to 12 of difficulties, of their own and of their friends.[2] All these facts point to the bodily condition, state of health or fatigue, and the like, and also the mental condition, that is, whether or not the child is well adjusted during the day, as the determiners of subject matter of his dreams.

Dreams of Adults. Some dreams of adults are plainly wish-fulfilments. Arctic explorers, for example, are said to dream nightly of sitting down to a sumptuous dinner by a warm fireside at home. In most dreams, however, the real motive is not so apparent and sometimes it is completely hidden until the dream is later interpreted. Let us examine the following example of a dream reported by an intelligent young woman while studying her first course in psychology. It is typical of dreams that are aroused by unsolved personal problems, and shows how a dream may occasionally throw light upon the things that are bothering individuals, even without their realizing it. The report is given in the young woman's own words.

A Chicken-Pox Dream

"I had a dream the other night that was so vivid that when I awoke I felt as though I had actually experienced what took place in the dream. I have two boys; one is five and the other three. I dreamed that they were shut up in an attic, that I couldn't get to them. I finally broke down the door. The older boy was covered with specks—all broken out with something. My oldest sister appeared. She insisted that I leave the boys there. A grand argument followed wherein I told her what I intended to do. Then I did it. I took the children with me to my own home.

"This dream fits in so perfectly with my own past experiences that after reading the assignment for this lesson I can laugh at it; before it really bothered me.

"The children being shut up in the attic is explained by the fact that due to unfortunate circumstances I was forced to give up my two boys (for the time being at least). I didn't have the say-so of this matter, since I am dependent right now upon my relatives. This explains why I could not get to them. The older boy being

broken out is due to fear. I had not seen them for three months when the opportunity to do so presented itself, but I had my two other children with me at the time and they had just gotten over chicken-pox. The fond relatives insisted that I was being very unreasonable to take a chance of exposing the boys to chicken-pox. I thought the other two were over it enough that they wouldn't get it but I wasn't sure. Besides this fear for the children I also had the fear of having some one tell me it was my fault. The argument and the rest of the dream are due to desires. The end of the dream fulfilled my chief desire. The argument was due to self-assertion motive as well as desire. My oldest sister is 20 years older than I am; she still treats me like a child. I have been in such a situation that I have had to listen to her while longing to show that I did have common sense."

Are Dreams Prophetic? Many a dream has been taken as a prophecy of future events. After some striking event has happened, like an accident, a flood, a crime, or an illness, some one is likely to come forward with a dream that could be interpreted as forecasting the event. Even without discounting the correctness of these reports of prophetic dreams, need we accept them as evidence that the dreamers had real foreknowledge of the event? There is no known basis for such foreknowledge.

A study of this possibility was made some years ago in connection with a most distressing event, the kidnaping of the famous Lindbergh baby. Before the body of the murdered child had been found, while a desperate search was still being made for him, people were having dreams concerning his whereabouts. Thirteen hundred of these dreams were collected by the psychologist Murray.[3] Only 5 per cent of these dreams reported the child dead, in spite of the fact that from previously known kidnapings death of the victim is quite a common outcome. We may put this discrepancy down to the common wish that the child be found alive. Only four of the 1300 dreams had the three correct significant facts, that the child was dead, that he was buried in a grave, and that this was under some trees. Those three facts were reported singly in many other dreams, so often that you would expect more than four people to mention them together even if there were no real prophetic virtue in their dreams.

The forecasting of events in dreams is probably no better, if as good, as while we are awake. The belief in any mysterious superiority of dreams as prophetic devices must be put down as wishful thinking. There is one exception. Future actions of the dreamer himself may often be correctly predicted from his dreams. But the prediction is more readily seen by the psychologist to whom the dream is told than by the dreamer himself. For example, one person's dream suggested that he was contemplating suicide. Another dream forecast ideas of divorcing the dreamer's husband. For these predictions there is some real psychological basis.

The Inventive Process

Stages in the Inventive Process. The act of inventing something of consequence is so rare and so hard to control that it cannot well be studied experimentally. You cannot place an ordinary individual in a chair in the laboratory and simply tell him, "Now create," and expect to get results. Even composers, writers, and inventors probably could not deliver under such circumstances.

Fortunately, a number of important creative people have told us as well as they can how their brain children come into existence. Their stories agree in a striking way, so that we are able to glean the following picture of the inventive process. There are four well-defined stages: (1) Preparation, (2) Incubation, (3) Inspiration, and (4) Verification. The first three are essential. In the popular mind, the stage of "inspiration" is the key to invention. It is, of course, the most obvious and spectacular one, but it is only the end result of the two that precede it.

Preparation. This is a fact-gathering period; a period in which experiences are accumulated. Every creation comes from past experiences; the parts are old but the pattern is new. Where there is no equipment of experiences there can be no invention. It is said that a year before he wrote *The Ancient Mariner,* Coleridge stated that in preparation he had "read almost everything." It took another writer 639 printed pages to tell about the many sources that Coleridge had read in preparation for his classic poem.[4]

The collection may be guided by some known kind of creation toward which the person is working. On the other hand, it may be a rather aimless browsing about, simply observing all one can. In the fields of science and invention there are usually more definite ideas of the kind of end product to be created. In the fields of art there is a more leisurely shopping about, with personal interests the selective agent. Goethe expressed the idea of preparation very well in the words, "We can do nothing but pile up the wood and let it dry; it will catch fire in due time." To the young person who would be creative in any field excellent advice would be to "pile up the wood"; it will "catch fire in due time."

Incubation. After preparation comes a period of waiting. New patterns of thought will simply not emerge at will. For some reason it takes time for the collected materials to fall into place. This seems to be a period of no progress, but a period that is essential if we are to accept the word of creative people. The individual is still set for the kind of product he wants and at least to this extent he remains active in his work.

Many observers are convinced that there is unconscious mental work going on during the incubation period. Certain signs seem to indicate this, such as momentary glimpses or previews of what is to come, and vague feelings of progress. It is difficult to say whether the mental set keeps things working out while the individual waits or whether the time interval merely gives interfering factors time to be cleared out of the way. Even if we accept the idea of unconscious mental work, however, it tells nothing about how the work is done. That is what we really want to know.

Inspiration. Inspiration is often startling in its suddenness and its newness. In this respect it is comparable to the moment of insight in learning or reasoning. Here the new pattern is seen for the first time. Sometimes there is said to be a warning or premonition that something of importance is about to appear. There is a feeling similar to that when we are trying to recall a name that is "just on the tip of our tongue" but not quite in view. As in the case of simple recall, the inspiration cannot be forced; efforts may interfere. It may come at some very inopportune or surprising moment when the individual is occupied with some-

thing else. It is said of Beethoven that the moments of inspiration often came upon him when present at lively social functions, and also on the street, to the astonishment of passers-by. Some moments of inspiration come during dreams. For example, Tartini's *Devil's Sonata* came in the form of a dream picture. The Devil appeared, playing the new composition on his violin.

Verification. After inspiration comes the time for self-criticism. Is the new pattern good; is it beautiful; will it work? No product of imagination is necessarily good, or true, or beautiful just because it is novel or because we created it. Creations in science or invention can be checked upon by making realistic tests; they must be consistent with reality. Creations in the arts must pass the test of satisfying human motives. If the creator's self-criticism is insufficient, the criticisms of his fellows will help in the selection and rejection of creations.

Self-criticism is best delayed until after the moments of inspiration. When criticism is applied too early, inspirations are not likely to come. Many a person who could be creative kills off the inventive process before it is well started. There is an old bit of advice to writers that fits this point very well. "Better to compose with fury and correct with phlegm than to compose with phlegm and correct with fury."

These four steps in creation are merely descriptive in a superficial way. They do not tell us very much about the nature of the mental events that occur during the act of invention. The next few paragraphs will suggest some of the abilities and traits that seem important.

Inventive Talents. What does it take to be creative? What kind of people stand out as being unusually talented in this respect? A few studies of such people yield some consistent pictures.

Musical Composers. The typical musical composer is gifted with a rich and vivid imagery for tones. Streams of tonal patterns flow spontaneously much as in a dream. The composer may learn to exert some control over this flow of images and use it to suit his desires. Compositions come in segments which he plays and memorizes and links together later.[5]

Poets. A comparison of poetic with unpoetic students showed that those with some poetic gift had more ability to give rhymes for words, larger vocabularies, better imagery, better memory for poetic material, and particularly, more ability to grasp figures of speech and to see very remote similarities between things. They were not superior in appreciation of rhythm.[6]

Artistic Children. Children who exhibit unusual talent for drawing and painting have certain advantages over unartistic children. Their observations are more complete and accurate, they have a much better memory for details, and they show great originality in arranging meaningless lines and objects in artistic patterns.[7]

Inventors. Patent attorneys, directors of research, and inventors themselves have been questioned about the make-up and habits of inventors. The outsiders give the inventors credit for having unusual originality, analytical ability, and perseverance. The inventors modestly credit their success to hard work and perseverance. They admit that they must first make a careful analysis of the need, then they survey the available information and finally formulate the solution. Some inventions come in a flash of inspiration, but others come slowly and piecemeal.[8]

No Single Creative Ability. It should be clear from these very brief examples that there is no one mental ability that can be called creative imagination. In each field of creation, music, poetry, invention, different special talents are brought to bear. If there is any one thing that all have in common it is the ability to reorganize experiences. This means a breaking down of old patterns in order that new ones may form. The key to this may be an attitude rather than an ability—an attitude of flexibility. Some people strive toward stable patterns, and once those patterns are established they resist change. Others keep their patterns in a more plastic condition, subject to alterations. Ask a number of your friends to think of a four-letter word ending in "e-n-y." Some of them, set for a word with its accent on the first syllable, as the habitual pattern would require, have difficulty in thinking of the correct word "deny." The attitude of being set for

change is one that can probably be developed to a large extent. Some of the other talents are not so readily acquired through practice.

Factors Related to Creative Thinking

The Development of Creative Abilities. The question has just been raised as to whence creative talents come, to what extent they are inborn, and to what extent they are acquired through practice. The general question of heredity versus environment is treated more fully elsewhere. For the present we confine ourselves to a few facts concerning a limited number of abilities.

Heredity Undoubtedly Important. One has only to remember the many geniuses who showed spontaneous evidences of their talents very early in childhood to be convinced of the importance of heredity. Mozart, composing at seven, is the classical example. In contrast with this, think of the hundreds of boys who are trained in music for years without ever becoming composers. A crucial example has recently been cited by Meier.[9] A boy, who was born blind but gained his vision at the age of seven, showed almost immediately an unsual talent for painting, both as regards composition and the use of colors. He had had no instruction and his home environment was rather unfavorable for encouraging artistic development.

Training Brings Out Talent. Some experiments in training children show that artistic talents can be improved to some extent. Children in a state art school in Germany, although not selected for their talent, were said to have been developed into creative individuals by special training.[10] The secret of the improvement was thought to be the unusual freedom of expression permitted the children. In another experiment, 10 inferior and 4 superior children were given special training for a period of two years in "free expression and motivation." A radical change took place in their artistic abilities.[11]

These experiments suggest that many children have more latent artistic talent than is ordinarily believed. And it is prob-

ably true that the imaginative efforts of many children are rather thoroughly discouraged by social pressure. The average child's mental life is rich with imaginative creations. Partly because he is faced with stern reality to which he must adjust himself, and partly because he is shamed by his elders, he gradually relinquishes his imaginative pastimes. Those who inherit exceptional talents probably survive in the face of these discouragements, as history has shown. Perhaps not many creative geniuses of first rank have been cut short by their repressing environments, but many a child of lesser talents has been thus hampered in his development.

The Creative Years. Because the creative person must break down old ways of thinking in order to construct the new, it has been a popular idea that only youth can be really creative. The middle-aged and those past middle age are thought to be too set in their habits of thinking. It is easy to point out creative geniuses who made their everlasting marks on the world when still quite young. One thinks of Keats, who died at 26; Schubert who died at 31; Alexander the Great who had conquered the world at 33; and of Christ who had started one of the world's great religions before dying at 33.

We do not know, in these few instances, what greater contributions these same individuals might have made had they lived to a ripe old age. But we can cite comparable contributions made by others at more advanced ages. Milton began writing his *Paradise Lost* at 50. Goethe began the writing of *Faust* at 57 and wrote the last part at 82. Victor Hugo wrote *Les Miserables* at about 60. Handel's *Messiah* was composed at 56, Wagner produced his best music between the ages of 46 and 69, and Beethoven was composing his best music at the time of his death at 57. Great artists have continued to do masterpieces when past 70. Scientists have made some of their greatest contributions when past the age of 50. Edison and Marconi, to mention two inventors, were still making significant inventions when they died at advanced ages.

When Best Contributions Are Made. But these are scattered and isolated facts. They are little better than anecdotes. Fortunately, Lehman has made a systematic study of the ages at which

creative geniuses have made their greatest contributions.[12] After collecting the great contributions from various fields, he had them rated for importance by competent men in those fields. He then determined the age of the genius when his *best* contribution was made. For each five-year interval of life he found the average number of best contributions, taking into account the number of geniuses who were living at those ages. The results are summarized in Table 20.2. In most of these fields it must be remembered that best contributions may actually come all the way from ages 20 to 80.

TABLE 20.2.—THE AGES AT WHICH THE LARGEST NUMBER OF BEST CONTRIBUTIONS ARE MADE IN SCIENCE, INVENTION, AND LITERATURE *

Field	*Number of Contributors*	*Number of Contributions*	*Best Years*
Poetry	82	797	26—30
Chemistry	244	993	28—32
Physics	90	141	30—34
Inventions	402	554	31—35
Short Story	220	1396	31—37
Mathematics	163	453	34—38
Literature	101	224	38—42
Astronomy	63	83	43—47

* From Lehman.

Fig. 20.1 shows how the best contributions distribute themselves over this entire range in the fields of literature and chemistry. The data in Table 20.2 show when the best contributions are most likely to come.

The Productive Years. These results say nothing about the productivity of creative people, that is, *how much* they produce at different ages. Productivity continues at a high level even after the age of best contributions is passed. Fig. 20.2 shows that the *quantity* of production remains at a high level from ages 30 to 60 and then declines only gradually to the age of 80. A probable cause of the early age for best creations is that younger individuals work with greater abandon, and in the case of writers they usually have a message that they wish to give the world. With age comes more self-criticism, conservatism, and consequently, relative dullness.

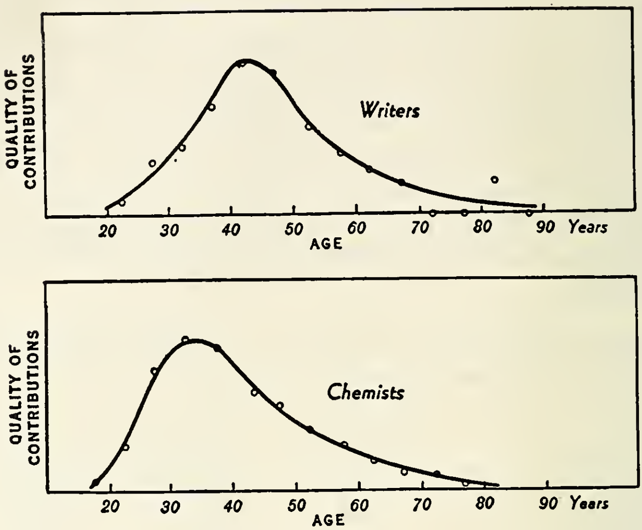

Figure 20.1. The years at which the best contributions are made in the fields of literature and chemistry. The height of the curve at any point depends upon the proportion of the contributors living at that age who make their greatest contributions then. (After H. C. Lehman, courtesy of *The Scientific Monthly*.)

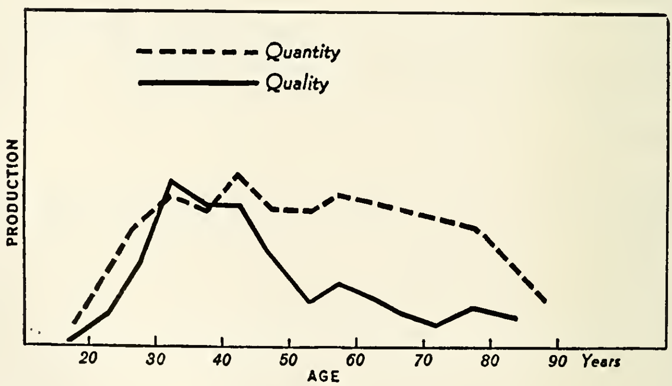

Figure 20.2. A comparison of quality and quantity of productivity of writers at different ages. Note that while the quality drops off after 40, the quantity remains at a high level until about 80. (After H. C. Lehman, courtesy of *The Scientific Monthly*.)

When we remember that the development of ability reaches its maximum in the early twenties and then begins its slow decline, we see how very important the collection of experiences is for creative work. One who expects to be creative should govern his life accordingly. In his twenties he should be content to "pile up the wood" and should be assiduous in the pursuit of knowledge. In his thirties he should expect his best creative fruits to be ripened. If they should fail to materialize then, he should not be discouraged. They may come later and with increasing frequency.

Social Factors in Invention. Something should be said about the great amount of borrowing of ideas that goes on in creative work. As in reasoning, two heads are better than one. One persons' new patterns are improved upon by another's alterations and amendments. Fig. 20.3 shows how the huntsman's bow, by successive changes, became a musician's harp. Many human brains were brought into use before the final transformation was complete. From the harp have come other stringed instruments, because other brains created improvements. In this manner do human inventions grow, each inventor standing on the shoulders of those who preceded him.

Are Creative Individuals Maladjusted? There is a popular impression that creative people are maladjusted to life, if not plain neurotic. Genius and insanity have been closely associated in the popular mind. A part of this belief might be credited to the average man's envy of the genius. "He may be a genius, but he is crazy" would be the expected comment. Many men of genius do act queerly, and the fact that they differ in their interests and gifts from the bulk of humanity sets them aside as "queer."

There is probably much truth in this popular opinion. In the first place the typical creative genius is extremely sensitive and responsive to stimuli; he is delicately adjusted and unusually complex. He is therefore in danger of becoming eccentric if not neurotic.

Gifted Children Well Balanced. In early childhood gifted children do not show signs of unusual maladjustment. Children

in grades I to IV were tested for musical and artistic talent and were also rated by their teachers for maladjustments.[13] On the whole the gifted children were rated as better adjusted than the rest. But many gifted children sooner or later sense their own peculiarities, follow their own personal interests, and become more and more solitary and eventually less well adjusted to their

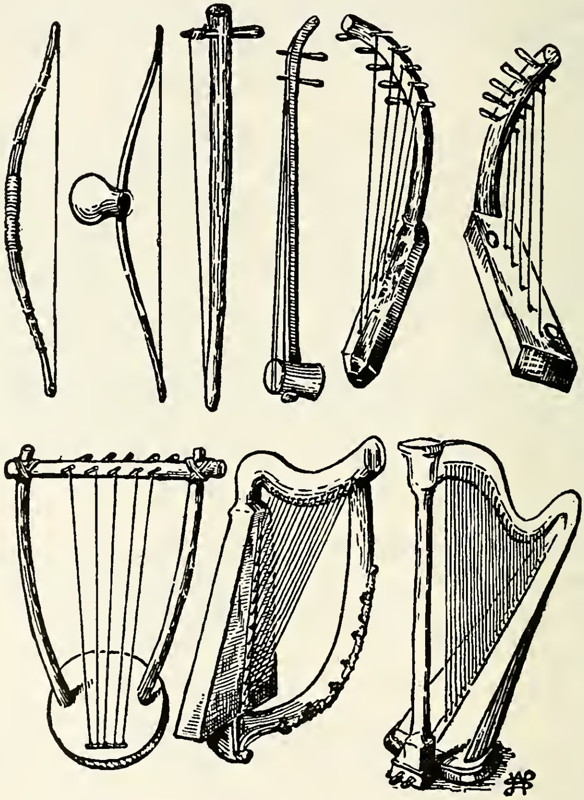

FIGURE 20.3. The evolution of the harp from the huntsman's bow. (Adapted from the *Literary Digest*.)

social groups than most children. Many are emotionally driven to creative superiority as a compensatory measure. Others are creative from sheer creative talent, but, because of their unique interests and appreciations, they lose the common touch and are likely to become eccentric.

Talented Adults Often Maladjusted. A study of 300 notables showed that 12 per cent of the group were psychotic (had strong symptoms of insanity) as compared with only one-half of one per cent of the general population, and as many as 30 per cent showed definite maladjustment.[14] There have been some well-adjusted men of genius, for example, Titian, Rubens, Verdi, and Dürer. One may wonder whether the maladjusted ones might not have wasted much of their energies on their mental conflicts and whether they might not have been even greater geniuses had they been well adjusted. The weight of the evidence, however, seems to be on the side of maladjustment and conflict as motivating creative effort. Real genius seems to depend upon two factors, (1) good inborn talents plus (2) strong motivation, usually born of conflict. Exceptional talent alone may be sufficient. Maladjustment alone in persons of mediocre ability rarely if ever suffices. Whether or not the pain and suffering of the maladjusted genius is worth the trouble, only the enduring value of his contributions will tell.

Summary

Although both reasoning and inventing are examples of creative thinking, reasoning is used to arrive at real conclusions about the world around us, while inventing aims at the production of what never existed before. While all human beings do indulge in creative thinking, only the rare few yield results that are of great social consequence.

Dreams are an example of inventions in which all of us indulge, by day or by night. Dreams during sleep are really dramatized sketches built around some incidental sensory stimulation and shaped under the force of internal motivating factors, usually motives that have been thwarted during the day. They have little or no prophetic value.

The entire inventive process shows typically the four stages of preparation, incubation, inspiration, and verification. The kinds of abilities exhibited by inventors in different fields are evidence that there is no single ability of creative imagination,

though all inventive people have in common the knack of breaking down old patterns of experience to form new ones.

Inventive talents are shown to depend upon heredity, but favorable environment can do much to bring out latent talent even of a mediocre sort.

The ages of life at which the best creative products may be expected vary for different fields, but most of the best products appear in the range from 30 to 50. The quantity of output of creative efforts continues almost undiminished to the age of 80 in those who live that long.

Creative results have always shown much borrowing, one creator simply adding modifications to the work of older creators.

Statistics show that while children who exhibit promise of creative genius are as well adjusted emotionally as other children, among adult creative geniuses the percentage of maladjustment is significantly higher than average.

Questions

1. What creative elements or aspects can you point out in connection with perception, learning, and reasoning, as well as with inventing?

2. What measures can a person of moderate abilities take to make himself more creative?

3. Give an account of one or two dreams you have found, and after investigating the surrounding circumstances of the dreamer and his dream, try to interpret the real significance of the dream.

4. A great inventor once said that "Genius is four per cent inspiration and ninety-six per cent perspiration." How much of this is psychologically true? What do you think the inventor meant?

5. What measures would you take in bringing up a child to foster creative talent in him? Explain.

6. How do you account for the fact that although human abilities usually reach their peak during the early twenties, creative genius reaches its peak in the thirties and forties?

7. There is a two-way relationship between creative talent and a tendency toward maladjustment. Explain.

8. Is there any evidence in this chapter that the creative genius matures more slowly and at a later age than other individuals? What is another interpretation of the same evidence?

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CHAPTER XXI

Human Abilities

Individual Differences

Up to this point we have been interested in those mental activities and powers that people have in common, with little being said about how one person differs from another. In this and the following chapter we shall emphasize differences.

Differences Are the Rule. Although all human individuals have the same kinds of mental activities and all obey the same basic psychological laws, they are far from equal or identical in make-up. Every human being is unique. He has his peculiar pattern of characteristics. He does resemble other people, if you consider each one of his characteristics at a time. In one respect he is like person A, in another respect like B, and in still another like C, and so on. Although people have characteristics in common, they possess those characteristics to different degrees and in different combinations.

Abilities and Other Traits. Some of these characteristics have to do with *proficiency* in certain tasks. Some persons can perform the same tasks more quickly than others, or they can do more difficult things than others. This is because they have different amounts of the required abilities. Other characteristics have to do with the *manner* in which individuals do things. One person is hurried and nervous, while another is calm and composed. One

does not grant himself a chance of winning, expecting to lose from the start, another is self-confident, expecting to win. These differences are in temperament traits. It is the responsibility of psychology to identify and to describe the abilities and other traits of people, and to devise ways of measuring them.

Psychological Tests

Individual differences are measured by means of psychological tests. There are tests of abilities and tests of other personality traits. Here we shall consider only the tests of abilities.

Some Principles of Psychological Tests. A psychological test is any task in which some mental activity or activities are required, and from which a score of the "goodness" of performance can be obtained. In some tasks speed is an important element. The score can be given in terms of number of items completed in a given time or in terms of the time required to complete a given number of items. For example, a simple test of addition could be scored thus. In some tasks accuracy is important. The score can be given in terms of the number or percentage of errors. In other tasks the level of difficulty is the important thing, and the score depends upon how difficult an item the person can pass.

Tests of Intelligence. Every student has heard of intelligence tests or "IQ" tests. The term "intelligence" was inherited by psychology from biology. What its real nature is like we shall see in the last part of this chapter. For the present let us simply let intelligence stand for the fact that some people are generally more mentally capable than others. Attempts to give intelligence a scientific definition have failed. It is not a thing or entity. If you will examine so-called tests of intelligence you will find them composed primarily of tasks requiring perception, memory, and thinking. In other words, the tests of intelligence depend upon the abilities having to do with getting facts, remembering them, relating them, and using them.

Binet's Mental-Age Scale. After a few early failures to construct tests that would distinguish between bright and dull individuals, and between good and poor students, success was at last

attained by the Frenchmen Binet and Simon. These two men were commissioned by the French government, at about the opening of our century, to find some tests that would pick out in advance the dull children in the schools of Paris so that they could be segregated from the rest. They found many scattered tests already in existence. Their task was to collect them, to add some tests of their own, and to construct a scale.

Mental Age. It was very early recognized that older children are more capable of passing the same tests than are younger ones. This gave the cue as to how to construct a scale or "yardstick" with which to measure brightness and dullness. Binet and Simon gave their single tests to a large number of children of different ages. A test that could be passed by about two-thirds of the six-year-old children was regarded as a six-year-old test. It would be passed by more than two-thirds of the children of seven and eight, and by less than two-thirds of the children younger than six. In this manner, they established the age level of a large number of tests, giving rise to a scale composed of several tests at every age.

The application of a mental-age scale of tests like the Binet-Simon scale proceeds as follows: A child who passes all the eight-year-old tests (assuming that he passes all those below that level and none above it) is regarded as eight years old mentally, no matter what his actual age may be. His mental age is said to be eight.* He may be six years of age, in which case he is advanced two years mentally. Another child with a mental age of eight may be eleven years old, in which case he is retarded three years. Brightness or dullness can then be given in terms of number of years advancement or retardation.

Intelligence Quotient. The number of years of advancement or retardation proved not to be a very satisfactory measure of brightness or dullness. A retardation of two years when a child is only six years old is much more serious than a retardation of two years when a child is twelve or fifteen. The difference between mental age and chronological or actual age does not remain the

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* In most cases a child does not pass all tests up to a certain point and then fail on everything above that point. There is a zone of uncertainty of which we must take an average in order to find the correct mental age.

same as the child grows older; it increases in proportion to the age. Brightness or dullness is therefore much better expressed as a *ratio of the mental age to the chronological age.* This gives the *intelligence quotient.* In terms of an equation,

$$\text{Intelligence Quotient} = \frac{100 \times \text{Mental Age}}{\text{Chronological Age}}.$$

Or

$$\text{IQ} = \frac{100 \times \text{MA}}{\text{CA}}$$

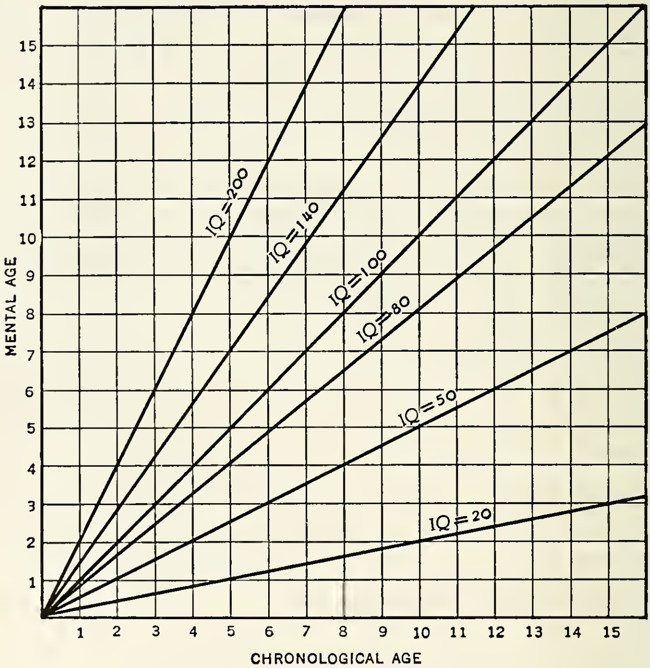

FIGURE 21.1. Lines showing the relationship between mental age and chronological age for different rates of development.

A child whose mental age is 8 but whose chronological age is 6, would have an IQ of 800 divided by 6, or of 133. Another child whose mental age is 8 and whose chronological age is 8 would have an IQ of 100. If the mental age of the child is 8 and his chronological age is 11, his IQ is 800 divided by 11, or about 73.

Fig. 21.1 shows several hypothetical cases. Mental age is plotted

along the Y-axis and chronological age along the X-axis. Each slanting line represents the development of a single child. For a child whose IQ is 100 exactly, his mental age increases just as rapidly as his chronological age. His line slants upward at a 45-degree angle. For children with IQ's below 100 the lines slant upward at smaller angles; for those with IQ's above 100 the slant is steeper than 45 degrees. The IQ is in proportion to the slope of the line, thus it represents *rate* of growth. The mental age means something quite different. It tells *how far* the child has developed in terms of age norms. It is a measure of mental "stature," or mental maturity, whereas the *IQ* tells us how fast mental "stature" is increasing. The IQ is an index of brightness.

IQ's of Adults. The normal rate of growth of measured intelligence slows down beginning in the early teens. Beyond the age of 15 the increase in measured intelligence is very small. Mental-age years above 15 are not comparable with those below 12. For this reason, we do not let the CA in our formula increase as rapidly after the age of 15, but make some necessary adjustments, too detailed to be explained here. The result is that the IQ can remain the same for a person as it was before the age of 15. As a matter of fact, the IQ of an adult has a different meaning than that of a child. On the one hand, it enables us to predict backward, so to speak. From it we can estimate about how rapidly the person had been developing mentally when he was a child. On the other hand, it enables us to place the adult in a certain position in the total range of adult brightness.

Constancy of the IQ. In connection with all tests that yield an IQ the question often arises as to whether you can depend upon that index of brightness to remain constant. There is a popular belief that a dull child may outgrow his dullness and become a normal or even a bright adult, and that a very bright child may turn into a mediocre or dull adult.

Uncounted experiments show that this belief is decidedly wrong. The dull child almost without exception becomes the dull adult; the bright child becomes the bright adult. The IQ does remain relatively constant. If a child tests with an IQ of 130 today, you can count on his IQ being within ten points of that

value almost any time in the future, unless something radically modifies his development. If another child has an IQ of 70, the odds are decidedly against his ever reaching an IQ of 100, to say nothing of a higher figure.

In most experiments, half the children who are retested change less than 5 points either way from their first IQ. Changes as large as 20 to 30 points can of course occur, though very, very rarely. Bright children are likely to fluctuate more than are average or dull children, but they shift upward as well as downward. Dull children change least of all. If there are any progressive changes at all, one is a very slight gain in the average IQ's of bright children and the other is a very slight loss in the average IQ's of dull children. The vast majority of changes are haphazard in direction. A child's IQ, then, is something that is rather characteristic of him. Knowing his IQ at the age of four, and even younger, we can predict that it will be reasonably the same when he is ten or twelve or even older. But we can be more sure of our prediction made at the age of six than if made below the age of three.

Revisions of the Binet Tests. Binet's first scale of tests was published in 1905 and it was twice revised before being translated into English and adapted to American children. The most famous revision has been the Stanford-Binet, made under the direction of the Stanford University psychologist, Terman, and published in 1916.

The Stanford-Binet test has been translated into many languages and has become more or less the standard test for children the world over. In 1937 a new revised edition was published, in two alternative forms.

Other Kinds of Tests. The Binet tests, and others like them, were designed to measure something that is necessary for school success. This places a high premium upon the use of language and other school material. The tests cannot pretend to measure abilities that are independent of school training or training similar to that obtained in school. But, by assuming that children have had equivalent opportunities to learn the necessary responses, it is thought that the tests do measure something that is fundamental in persons, something not changed by learning. Some even

maintain that they measure inborn or native intelligence. If this assumption is made, one should be cautious when applying the tests to children who are not comparable in educational and cultural opportunities with those upon whom the tests were originally standardized. In order to test other children who are obviously not comparable—the children of foreign-born parents and the deaf, and the otherwise handicapped, for example—new kinds of tests had to be invented. For them some nonlanguage tests were constructed. These we call performance tests.

FIGURE 21.2. Material used in the "Arthur Point Scale of Performance Tests, Revised Form II." (Courtesy of the Psychological Corporation.)

Performance Tests. Examples of performance tests are given in Fig. 21.2. The form board is typical of this class. Geometric forms are cut out of a board, and sometimes the pieces are cut in two or more parts. The instructions to the child may be given in pantomime, if he does not understand the language. He can be scored for both time and errors, and age norms for both scores

are known so that mental-age ratings can be given for both. From a number of these tests, more than a dozen mental-age ratings can be obtained. Their middle value is taken as the most probable true mental age of the child. An IQ can then be calculated.

Group Tests. When mental testing on a large scale was finally started, it was found that, owing to the limited number of testers, and the enormous numbers of school children, the business of testing was slow and tedious. The idea of mass production was carried over into the field of testing, and the group test is the result. Although they are not yet regarded as accurate as individual tests, they serve very well.

Aptitude Tests. Aptitude tests are designed for a particular purpose, namely to predict whether a person, before he is trained, will probably become a successful worker in some field. There are such tests for aptitude in handwork, tool work, typing, clerical work, selling, aviation, and other kinds of work. Most colleges and universities give to their entering freshmen college-aptitude tests to help determine fitness to undertake four years or more of college work. These stress vocabulary and aptitudes for the study of mathematics, language, and science.

Achievement Tests. Achievement tests are given after training. All school course examinations are achievement tests. Tests of elementary and high-school subjects are standardized for age and for grade. Tests of such college subjects as English, languages, science, and mathematics have also been standardized.

Differences in Abilities

Distribution of Ability. Popular notions would divide people into two extreme categories; the bright and the dull, the fast and the slow, the accurate and the inaccurate, and so on. The facts are quite otherwise. When we give a psychological test to a population, the majority of the people are found to be mediocre, and the extremely good ones and the extremely poor ones are very rare.

Fig. 21.3 shows how large numbers of individuals are distributed along the scale of skillfulness in a number of psychological

tests. The vertical distance represents the numbers of people making certain scores and the horizontal distance represents the scale of test scores. In every case the people bunch together near the middle of the range of scores. Near the center of the cluster

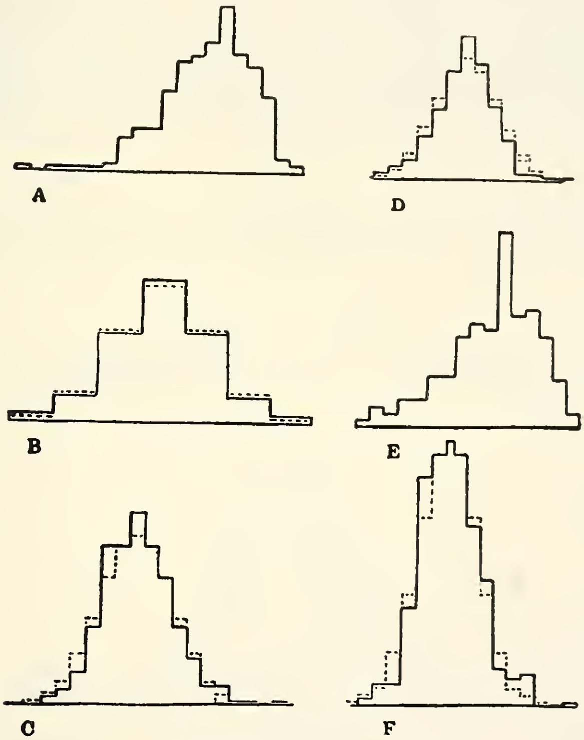

FIGURE 21.3. Samples of frequency-distribution curves for six psychological tests. For each level of test score (each scale of scores is represented by the base line) the height of the column represents the number of individuals who make that score. (After E. L. Thorndike, in C. N. Rexroad, *General Psychology*, The Macmillan Company.)

A. Reaction time scores; 252 college freshmen.
B. Memory for digits; 123 students.
C. Cancellation test (crossing out a letter in pied type) : 312 boys.
D. Giving opposites in an association test; 239 boys.
E. Line-drawing test; 153 girls.
F. Cancellation test (crossing out two letters) : 312 boys.

is the average score for the sample tested. As one goes away from the average in either direction, the number of cases decreases.

When our tested sample is reasonably large, at least 100, when we take persons at random, and when our test is neither too easy

nor too difficult, the distribution approaches a bell-shaped form, such as those in Fig. 21.4. This form is known as a normal distribution. If, by chance, we select relatively more of the able individuals, or if the test is too easy, there will be a bunching of cases near the upper part of the range of scores. If, by chance, we select more of the less able individuals, or if our test is too difficult, the bunching will be near the lower end of the range. Other factors may make our curve irregular. But under the conditions laid down

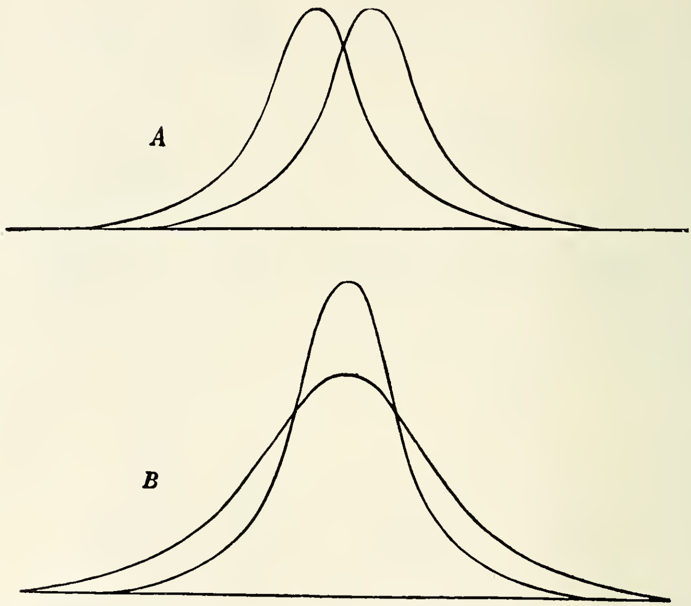

FIGURE 21.4. Normal distribution curves. The two distributions in *A* differ with respect to averages but have equal dispersions. The distributions in *B* have the same average but differ in dispersion.

above, with a large number of subjects selected at random, and a suitable test, the normal distribution curve is likely to occur.

How Distributions Vary. There are two important ways in which one group's distribution can differ from that of another. One group may have a higher average score than another, as when we compare two grades in the same school. The two distributions would look something like those in Fig. 21.4 A. Not all the children in the one group are higher than all in the other. There is

much overlapping of the two distributions. But the majority of the better group have scores above the average of the poorer group.

The other way in which two normal distributions can differ is shown in Fig. 21.4 B. Here the two groups have the same average score, but one of them has a wider scatter or dispersion above and below the average. Knowing how much each individual deviates from his group average, we can find an average of the deviations. The group with the wider scatter would have the larger average deviation.

Two groups of subjects can thus be compared by noting their average scores and their average deviations. It is often very significant to compare groups in this manner. Groups of older children ordinarily have a larger average deviation, as well as a higher average in a test, than younger groups. Boys and girls can be compared in the same way. In some tests girls have a higher average and, in others, a lower average, than boys. In some tests boys have a wider dispersion of scores than girls, and in some tests, a narrower dispersion.

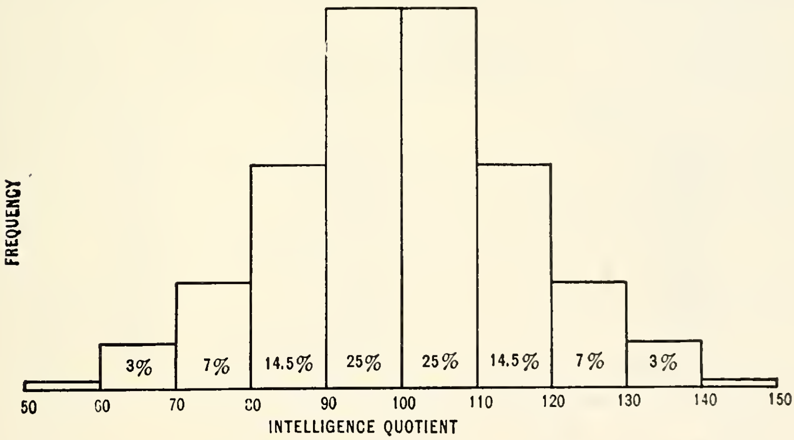

FIGURE 21.5. A distribution of *IQ's* of 3184 children. (Data from L. M. Terman and M. Merrill, *Measuring Intelligence*, Houghton Mifflin Company.)

The Distribution of IQ's. Fig. 21.5 shows the distribution of the population with respect to IQ. In standardizing the IQ tests

in the Stanford-Binet scale, attempts were made to see that the average IQ would be 100 and that the distribution would be normal.

This distribution tells a number of stories. Half the population falls within the limits from 90 to 110 IQ. They may be considered the "normal" group. The number of bright and superior individuals is offset by a like number of dull and inferior ones. Nearly 80 per cent of the population have IQ's between 80 and 120, 99 per cent between 60 and 140. Only one child in two hundred (0.5 per cent) is rated as a genius on the basis of his high IQ. As we shall see later, it takes more than a high IQ to make a genius in the real sense of the word, although a high IQ is one indication; hence the question mark after "genius" in Table 21.1.

TABLE 21.1.—THE DISTRIBUTION OF IQ'S IN A POPULATION OF 3184 CHILDREN *

IQ Range	*Description*	*Per Cent*
Above 140	Genius?	0.5
130-139	Very superior	3.0
120-129	Superior	7.0
110-119	Bright	14.5
100-109	High normal	25.0
90-99	Low normal	25.0
80-89	Dull	14.5
70-79	Inferior	7.0
60-69	Feebleminded	3.0
Below 60	Feebleminded	0.5

* After Terman and Merrill.

The Feebleminded. Feebleminded persons had been recognized long before there were mental tests. They were so lacking in mental ability as to be obvious to a good observer, and if they were social dependents or annoyers, they were segregated in special institutions when such institutions were available.

Degrees of Feeblemindedness. Three degrees of feeblemindedness were distinguished. The lowest type was called the *idiot,* who is distinguished for his inability to dress and feed himself and to avoid common dangers such as fire and water. The next higher type was called the *imbecile,* who can avoid common dangers and take care of his elementary personal wants, but cannot be taught to earn a living, even under supervision. There are differences,

however, between the lowest and highest imbeciles in these respects. The highest level of the feebleminded is the *moron*. The moron can be taught to do useful work and can sometimes earn a living, especially under supervision.

Mental-Test Ratings of the Feebleminded. When mental tests were first applied to the feebleminded in institutions, it was found that none had an IQ higher than 75. But it was also found that many persons outside the institutions had IQ's lower than 75. It was agreed arbitrarily to set the upper limit of feeblemindedness at an IQ of 70, when the mental-test rating is the criterion.

Social Adjustment of the Feebleminded. Many of the high-grade feebleminded, as judged by mental tests, can adjust themselves well enough outside institutions, while some of them cannot. In one study, when 136 individuals were released from an institution, 63 per cent were absolute failures at self-support and only 14 per cent were socially and economically successful.[1] In another study, however, of people with IQ's below 75, 53 per cent were successfully adjusted and only 21 per cent were flat failures.[2]

TABLE 21.2.—A SUMMARY OF THE FACTS OF FEEBLEMINDEDNESS WITH BOTH SOCIAL AND PSYCHOLOGICAL CRITERIA

Grade of Feeblemindedness	*Social-Criteria*	*Test IQ*	*Mental-Age Rating at Maturity*
Moron	Can learn useful tasks. Can make a living and adjust socially under supervision.	50-70	8-11
Imbecile	Can care for simple personal wants and avoid simple dangers.	25-50	4-8
Idiot	Cannot care for self or avoid simple dangers.	Below 25	Below 4

In still another study, 206 individuals, who had IQ's lower than 71 as children, were compared with a like number of otherwise comparable people with IQ's between 100 and 120.[3] The subnormals had inferior homes, fewer were married, the death rate was much higher, lawbreaking was more common among them, and 61 per cent had failed to remain employed steadily, though 83 per cent had been self-supporting to some extent.

It depends very much upon the circumstances. In times of economic stress many people with IQ's well above 70 would not be

regarded as economically and socially successful. The facts of feeblemindedness are summarized in Table 21.2.

Genius. If for a moment we define a genius as one with an IQ above 140, what kind of children are geniuses? Not until we had mental tests to single out these children did we find out very much about them. Contrary to the common belief, these children are physically superior to the normal and dull. On the average, they are taller, heavier, stronger, are more comely and better formed, and have better health than average or dull children. They show their mental superiority by being accelerated in school, by having more intellectual and social interests and hobbies, by their greater qualities of leadership, emotional stability, social adaptability and good character traits. They play as much as other children, but are more likely to prefer solitary games and reading to violent physical exercise.[4]

One exception to this glowing picture of those with high IQ's is the fact that the chances for developing successful personalities are not so favorable in those with exceptionally high IQ's. The most favorable range of IQ's for developing successful personalities seems to lie between 125 and 155.[5] But, even in this range, care must be taken lest the bright child become alienated from his uncongenial fellows—uncongenial because of differences in interests and lack of mutual understanding.

Geniuses of History. An IQ above 140 does not guarantee outstanding social contributions or personal success. There must be sufficient motivation and other favorable traits besides.

Terman and Cox made an intensive study of the outstanding geniuses of history. It was too late, of course, to give them a mental test. But it was possible to give them a kind of post-mortem examination from tell tale evidence they had left in the form of biographies, letters, and other signs of precocity when they were children. An example of such evidence is a letter written by Sir Francis Galton, whose IQ was estimated to be about 200, just before his fifth birthday. It reads:

> My dear Adele:
>
> I am 4 years old and I can read any English book. I can say all the Latin Substantives and Adjectives and active

verbs besides 52 lines of Latin poetry. I can cast up any sum in addition and can multiply by 2, 3, 4, 5, 6, 7, 8, (9), 10, (11). I can also say the pence table. I read French a little and I know the clock.

Francis Galton
February 15, 1827

From such evidence the IQ's of 282 famous men of history were estimated. Some could be reliably determined, and some could not because of lack of material. In Table 21.3 are given some of the more reliably-determined IQ's of the better known men. None of this list, and none of the entire list of 282 individuals, was rated with IQ below 100, but many of them whose names will live as long as human records last, fall below the level of 140. This should be an encouragement to all those with better-than-average IQ's.

TABLE 21.3.—ESTIMATED IQ'S OF SOME IMPORTANT GENIUSES OF HISTORY *

IQ	*Names*	*IQ*	*Names*
200	Galton	145	Jefferson, Emerson, Franklin, Webster, Galileo, Milton, Laplace
190	J. S. Mill	140	Carlyle, Kepler, J. Watt
185	Goethe, Leibniz	130	Newton, Spinoza
180	Macaulay, Pascal	135	Darwin, Kant, Napoleon
170	Voltaire	125	Washington, Lincoln, Linnaeus
165	J. Q. Adams	120	Haydn, J. Adams
160	Pope, Pitt the Younger	115	Goldsmith, Swedenborg
155	Tennyson	110	Grant
150	Bryant, Wordsworth, Mozart, Longfellow, Hugo	105	Faraday

* From Terman and Cox.

The Composition of Intelligence

All attempts to define intelligence as a single entity have thus far failed. It has been called the ability to solve new problems, the ability to do abstract thinking, and the ability to learn. But the tests do not follow consistently from any of those definitions. One psychologist has astutely remarked that "intelligence is what the intelligence tests measure." We are thus thrown back upon an examination of the tests themselves. This does not mean a casual, armchair examination, not even with the trained

psychologist's eye. It means a statistical study of the ways in which the tests agree or disagree when they measure individual differences in a group of people.

The Coefficient of Correlation. The amount of agreement between two tests is shown by the correlation that exists between them. The strength of the correlation is measured by the *coefficient of correlation,* a statistical number. If two tests place the same group of individuals in exactly the same rank order, the correlation between them is perfect. The agreement could not be closer, and the coefficient of correlation is exactly +1.00. We would conclude that the two tests are measuring precisely the same ability or abilities. We could just as well replace one by the other. If two other tests gave scores that place the same individuals in somewhat the same rank orders, with a few exceptions to perfect agreement, the coefficient of correlation would be lower than +1.00, but it would still be positive, perhaps +.80 or more. If the exceptions are very numerous, so that from a person's rank in the one test you could hardly predict his rank in the other, the correlation coefficient is low but positive, perhaps +.30. When the coefficient of correlation is zero, there is no agreement in the two rank orders. A person who ranks first in the one test might rank anywhere in the other, from first to last, when the correlation is zero.

It is possible to get a negative coefficient of correlation, which means that there is a tendency to a reverse relationship. In this case, a person ranking high in the one test is more likely than not to rank low in the other. Perfect negative relationship would occur when the two rank orders are completely reversed, and the coefficient is then —1.00. As a rule, tests of abilities correlate positively with one another, all the way from zero to about +.90.

An Example of a High Correlation. In Table 21.4 may be seen an example of a simple correlation problem with only twelve subjects. The one set of test scores was obtained from the Army Alpha Examination, and the other set from the Otis test of intelligence. The subjects are arranged in rank order for the Army Alpha scores. The rank orders for the Otis scores agree fairly well, but there

are some discrepancies. The cofficient of correlation, when worked out by methods which we shall not go into here, is +.73.

The Reliability of a Test. No psychological test is perfectly reliable. The same person taking the same test at different times

TABLE 21.4.—SCORES AND RANK ORDERS OF TWELVE INDIVIDUALS IN TWO TESTS OF MENTAL ABILITY

Subject	*Score in Army Alpha Exam.*	*Score in Otis Test*	*Rank in Army Alpha Exam.*	*Rank in Otis Test*
A	183	65	1	2
B	180	62	2	3
C	176	60	3	4
D	175	67	4	1
E	168	45	5	10
F	165	53	6	8
G	156	54	7	7
H	152	56	8	6
I	150	58	9	5
J	147	42	10	11
K	142	40	11	12
L	126	47	12	9

would make slightly different scores. We can tell how reliable a test is by correlating the test with itself. This can be done in several ways. One way would be to repeat the test with the same group of subjects, get two rank orders,* one for the first time, and one for the second time, and then find the coefficient of correlation. Another way would be to give two different forms of the same test. Most acceptable tests have coefficients of reliability (that is, self-correlations) higher than +.90, although many useful ones have reliabilities between .80 and .90. Even less reliable tests are useful when combined with other tests in a battery.

These reliabilities compare very favorably with the reliabilities of clinical tests in medicine. Tests of blood pressure, metabolic rate, and the like, have reliability coefficients usually between .60 and .80. The reason for lack of perfect reliability in both medical and psychological tests, is that the individual is a changing quantity. The greater the time interval between tests. the lower the reliability coefficient is likely to be. An example of an almost perfectly reliable test, with only a few hours between the two ap-

* Other ways of computing a coefficient of correlation *not* using rank orders. are more often used. The use of rank orders is best understood by the beginner.

plications, would be the measurement of standing height. The measurment of weight, with only a few hours between, would probably have a reliability coefficient near +.98 due to actual fluctuations in weight.

Factor Analysis. Our interest here, however, is in the nature of intelligence, and in the abilities of which it is composed, for it is undoubtedly a composite of a number of abilities. We call these abilities that make up intelligence, *primary abilities.* We discover the primary abilities from the intercorrelations between tests. Some pairs of tests correlate very highly with each other, thus they have much in common; others correlate very little or none, thus they have little or nothing in common. It is by studying these high, low, and zero correlations that we decide what primary abilities are required by the tests. There are some very involved statistical methods for making this analysis from the intercorrelations. These methods are known as *factor analysis.*

Some Intellectual Primary Abilities. Intelligence may be regarded as composed of certain intellectual primary abilities. There are other, nonintellectual primary abilities, also, as we shall see later. We will mention first a few of the intellectual abilities that have been established by repeated research.

(1) *Verbal Comprehension.* This ability is best measured by ordinary vocabulary tests. Word knowledge seems to be the best way to describe it. It is also measurable by means of reading-comprehension tests and word-association tests, but both of these measure one or more of the reasoning abilities also.

Of all the primary abilities, this one is most heavily weighted in intelligence tests of the verbal type. It is, of course, the most important ability for success in most school subjects, since the medium of instruction is verbal.

(2) *Number Facility.* This ability has to do with the speed and accuracy with which numbers can be used, as numbers. The best measure of it are tests of simple addition, subtraction, multiplication, and division. Even the process of counting, when it occurs in tests, may involve some of this ability. It is not a general mathematical ability. Mathematical ability is a composite, includ-

ing numerical ability and one or more other primary abilities, depending upon the branch of mathematics.

(3) *Problem Reasoning.* The best measure of this ability is an arithmetical-reasoning test composed of items such as the following:

If a man's salary is $50 a week and he spends $38 a week, how long will it take him to save $300?

Any item that poses a problem requiring some trial and error in its solution seems to bring into play this ability. Many types of test items that become sufficiently difficult for the examinee involve this ability to some extent.

It is one of the most important abilities measured by intelligence tests. It is important in many school subjects besides arithmetic.

(4) *Logical Reasoning.* This ability seems to be a sensitivity to logical relations; the ability to judge whether one thing follows logically from another. A good test of it offers items of the following type:

Given: Most of the trees in the forest are green.
Which of the following statements follow logically from this statement?

A. There are no yellow trees in the forest.
B. There are some yellow trees in the forest.
C. Some of the trees in the forest are green.
D. Green trees in the forest are healthy.
E. The pine trees in the forest are green.

There are other thinking abilities as yet not very well defined by factor analysis. Some of these involve the seeing of relationships of various kinds and others involve the utilization of those relationships.

(5) *Associative Memory.* This is the ability to associate two items of perceived information such that when one is given later the other can be reported or recognized. The associating of names and telephone numbers, of names with initials, of faces and names, and of objects and names—all seem to be promising forms

of tests of this ability. It is probably important in all types of serial, verbatim memorizing.

(6) *Visual Memory.* This ability can be measured by exposing forms, patterns, objects, or maps, then asking for recognition of the same material when seen later among other such material or under somewhat different conditions. The time interval between memorizing and the recognition test may be very short. The everyday recognition of faces we have seen, or of houses, streets, or landmarks, may well depend upon this ability.

There is a good possibility that there is a separate ability to remember meaningful content or information. The two abilities mentioned above may be of much help in remembering information, but where the recall is to be in substance rather than verbatim, at least one other memory ability may come into play. For example, when instructions are given, as in briefing an aircrew about to depart on a bombing mission, a quizzing on the steps involved will show individual differences apparently unrelated either to associative or visual-memory ability. Thus, it appears to be quite incorrect to speak of an individual's "memory ability" as if it were one entity. He has several memory abilities. Some persons may be about equally good (or poor) in all of them, but the chances are that most people are of unequal stature in different memory abilities.

(7) *Visualization.* Besides having the ability to remember and to use visual memory of things, there has been demon

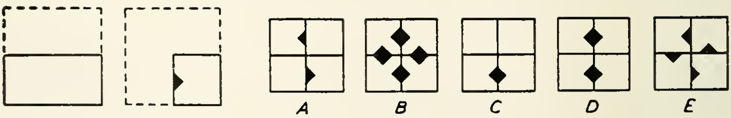

Figure 21.6. Imagine a piece of square paper being folded from top to bottom as in the first picture, then from left to right, as in the second picture. Then imagine a notch being cut out, as shown by the black triangle. How will the paper appear when unfolded? The right answer is D.

strated an ability to manipulate what we see; to imagine a change in something perceived. One good test of visualization is the paper-folding-and-cutting test illustrated in Fig. 21.6. One has to think how the paper looks as a result of the folding and the cutting of

holes. This is more than a kind of photographic memory. It is a manipulation of a visual pattern, seen or remembered, into a changed condition, or position, or pattern. This ability is important in many mechanical and engineering tasks. It is not very prominent in the ordinary IQ tests.

Conclusions about Intelligence. Tests of intelligence are thus seen to measure not one central ability, but a great many abilities, each one limited in scope. It should be said that not all psychologists hold to this idea of intelligence. Spearman, for example, believed that there is one important ability, "g" that is common to all tests of cognitive (knowing) ability, plus other abilities, most of them very specific. Factor analysis has thus far failed to prove the reality of a universal ability like "g."

The primary abilities are found to be relatively independent, in the sense that they are uncorrelated or nearly so. This means that a person may have a large amount of one primary ability and almost any amount of some other primary ability. This conclusion is supported by the fact that, in rare cases, imbeciles, so far as IQ is concerned, may excel remarkably in one ability, like memory, use of numbers, or visualization, and be low in everything else. This does not mean that the primary abilities do not operate together, for they do. Hardly a single task does not depend upon two or more of them at the same time.

The Real Meaning of an IQ. From the analysis of tests, we are forced to the conclusion that an IQ derived from one battery of tests does not necessarily mean the same thing as an IQ from another battery. It all depends upon the composition of the batteries, in other words, the primary abilities that are sampled by them. This is why there is often a surprisingly low correlation between the IQ's from a performance scale and those from a Binet scale. The one test battery may stress visualization and the other verbal ability. Both are so very complex in their make-up, however, that they sample some of the same primary abilities; otherwise they would not correlate with one another at all.

An IQ should be regarded as a general indicator of rapidity of mental growth. The mental age is an indicator of general mental maturity in a composite of the primary abilities sampled.

Some Other Primary Abilities

Not all tests are intelligence tests and not all primary abilities are intellectual abilities. Aptitudes for many kinds of work have little or no relationship to intelligence. In selecting and classifying personnel and in vocational guidance of individuals, it is sometimes more important to know about those nonintellectual abilities than to know about IQ's. Some of the best established perceptual and psychomotor abilities will be mentioned by way of illustration.

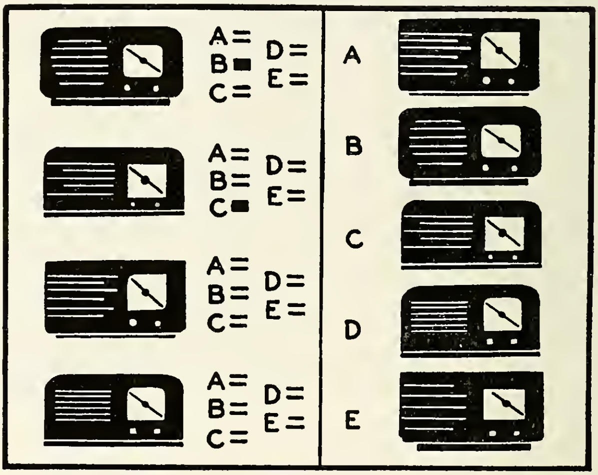

Figure 21.7. Sample items from a perceptual speed test. Which radio at the left is exactly like which radio at the right? The answers for the first two are already marked as they should be. (From Part IV of J. P. Guilford and W. S. Zimmerman, "Aptitude Survey," courtesy of the Sheridan Supply Company.)

Perceptual Primary Abilities. There are probably quite a number of distinct perceptual abilities (including sensory abilities). A few examples will be given in the area of visual perception.

(1) *Visual Speed.* This ability is measured by pictorial tests as illustrated in Fig. 21.7. The objects need not be meaningful. It is a matter of noticing small differences in form and pattern. The items are usually fairly easy and speed is important.

This ability is important wherever adequate reactions depend upon a quick observation of visual patterns. The aircraft pilot,

who often gets merely a glimpse of things and who must read instruments quickly and accurately, depends upon this ability. Clerical workers and inspectors of products in factories also must be fairly able in this respect.

(2) *Spatial Orientation.* This ability is probably the most important of all for the success of the aircraft pilot when not "flying on instruments." It is an appreciation of the arrangement of things in space when the frame of reference is one's own body. Decisions as to where to reach, in what direction to move, and

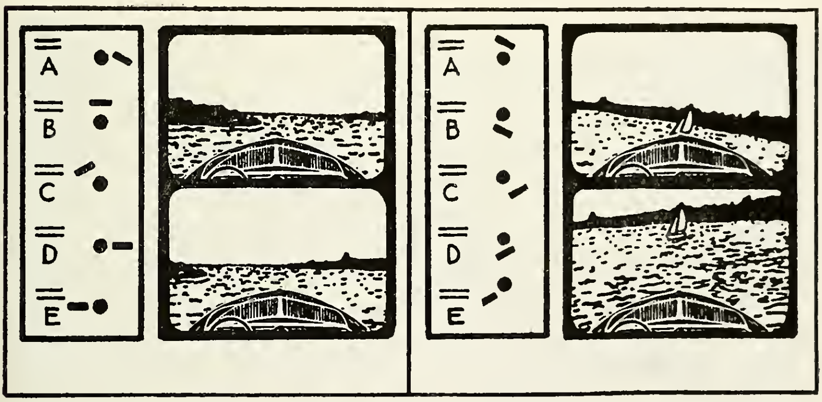

FIGURE 21.8. Sample items from a spatial-orientation test. If the position of the boat changes with respect to the background as we go from the first picture to the second, which symbol shows what the change was like? The dot in each alternative answer indicates the position of the tip of the boat's prow in the first picture and the rectangle represents the boat in the second picture. The correct answers are D for the first and B for the second. (From Part V of J. P. Guilford and W. S. Zimmerman, "Aptitude Survey," courtesy of the Sheridan Supply Company.)

what is the relation of one object to another in space depend upon having an organized idea of the layout of things. Fig. 21.8 shows one type of test of this ability. Other tests of it require the manipulation of machine controls. The ability is probably important in some form of athletics, football, for example, as well as in the operation of machines that must be maneuvered in space.

(3) *Visual Closure.* The ability to form total visual impressions out of loosely presented material is tested by means of items like those in Fig. 13.5. It is likely that the reading of radar scope

presents a problem that depends much upon this ability. Speed and clarity both seem to be important features of this ability.

(4) *Visual Analysis.* A somewhat similar ability is that of bringing about visual closure against distracting or competing closures. This is tested by means of items like the Gottschaldt figures (see Fig. 10.9). In such tests one must break down old wholes in order to use some of the material in forming new ones. This would presumably be useful in overcoming the effects of camouflage or in visual perception generally under difficult conditions, as in a dense jungle.

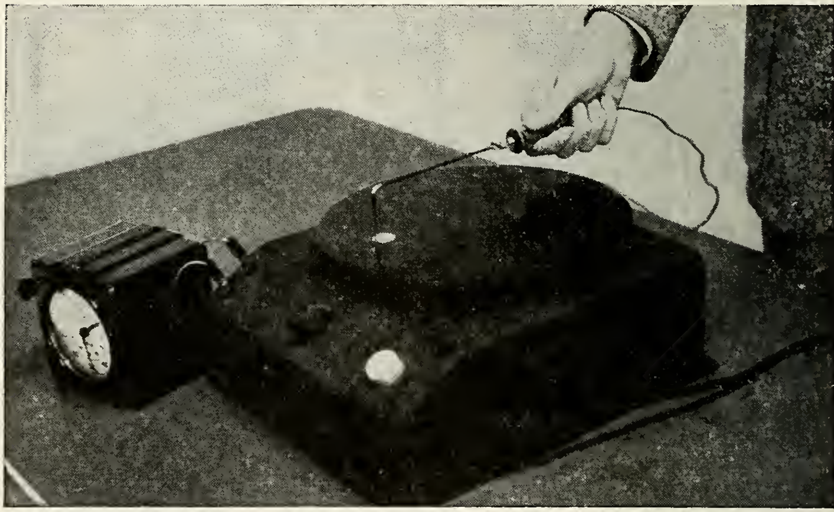

FIGURE 21.9. The rotary pursuit test. The examinee's task is to keep the point of his stylus in contact with a small copper disc on the turntable. His score is the amount of time he maintains contact as the table turns.

Psychomotor Primary Abilities. In the production of movements, in athletics, in machine operations, and so on, there are a number of abilities involved. Industrial psychology has long been concerned about these abilities in the selection and classification of personnel for jobs in which motor skills must be learned to a high level of proficiency.

(1) *Psychomotor Coordination.* This is an ability to control combined movements. One of the best measures of it is the common rotary-pursuit test as shown in Fig. 21.9. In this test, the

examinee tries to keep the stylus that he holds in his hands in contact with a small metal button on a revolving turn-table. The score is the length of time he maintains contact. This ability is important in any jobs or tasks in which the more gross activities of arms, legs, or hands are involved. There seems to be another primary ability involved in finer adjustments of finger activity. Finger-dexterity tests have been in use for many years.

(2) *Psychomotor Precision.* Accuracy of muscular control is another psychomotor ability. It is measured by aiming tests such as that in Fig. 21.10.

FIGURE 21.10. An aiming test. In rhythm with a metronome the examinee, starting with a completely flexed elbow, thrusts his pencil forward attempting to hit the the center of the target.

(3) *Psychomotor Speed.* Speed of movement is a third among the psychomotor primary abilities. This ability can be measured by a simple paper-and-pencil test. The examinee is told to make as many X's as he can in a limited time, the size of the X's being standardized for all examinees. Individual differences in reaction time (see Chap. II) are not a matter of this particular ability.

Tests of physical fitness and of athletic aptitude measure a number of additional primary abilities, including one or more strength factors. Tests of chinning, rope climbing, push-ups, and the like, measure arm strength, for example. Body agility is an

ability indicated by a test such as the "dodge run," which requires sudden changes of pace or direction.

Significance of Primary Abilities. There are many primary abilities that have not been mentioned in this brief review. The application of factor analysis has been so recent that we have much to learn yet concerning the number and variety of the factors, and concerning their properties. The knowledge that we already have of the primary abilities has proved to be very useful in understanding the domain of human aptitudes and in developing tests for their measurement for vocational uses.

Profile Methods. Where previously we were very much confined to the IQ and perhaps, in addition, a score for "mechanical" aptitude and one for "clerical" aptitude, all of these concepts have now been broken down. We can now describe each person by means of a *profile* of scores in the primary abilities. A profile is illustrated in Fig. 22.3. The traits represented there are not abilities, but the principle is the same.

The profile method has the distinct advantages of showing graphically an individual's *pattern* of strong and weak points. Certain combinations of strong points may be very significant in vocational guidance, for many jobs and occupations demand such combinations. If an occupation, or an assignment within an occupation, becomes known in terms of requirements that can be described in terms of a profile, vocational guidance then becomes a matter of matching individual profiles with occupational profiles.

A knowledge of weak points in individuals is also valuable at times in diagnosing failures. Where those weak points are correctable, steps can be taken to overcome them. Where they cannot be overcome, changes of assignment may be the solution. Thus, in many ways, knowledge of a person in terms of how much of each primary ability he possesses is an important step forward. This seems to be the direction in which vocational practices are now going.

Conditions Related to Abilities

Human abilities are so important that it is desirable for us to know what causes high or low status in them, and

what some of the consequences of variations are. If we know what determines high ability of any kind, we may be able to help produce it. If it turns out that we cannot change a person's ability, we can at least learn when to expect high ability and when not to. Among the conditions that we find related to abilities are: age, sex, family, race, heredity, environment, physiological differences, delinquency and crime. Some of these are causes, some are effects, and others are merely incidentally related to differences in abilities. The relative influences of heredity and environment, on IQ particularly, were discussed in Chapter III.

Age of the Individual. Mental abilities generally improve with age during childhood and early youth and decline with age when individuals pass their prime. In studies of this problem, one or another of the standardized intelligence tests has been employed: the Stanford-Binet, the Army Alpha, or the Otis group test. The picture of growth and decline derived from these tests is in part a composite one and in large part of growth and decline of the primary verbal ability. Each primary ability probably has its own characteristic rate of growth and decline and its age of maximum status.

Rate of Growth. A growth curve for intelligence is given in Fig. 21.11.[6] The test was the Stanford-Binet. The amount of ability was measured on a special scale on which zero was designed to mean actually no mental ability of the kind involved in the test and on which the units represent equal increments of ability. On this scale we find that the time of absolute zero ability comes some time before birth. The rate of growth increases from birth to the age of about ten, after which it slows down. Individual children would differ in some ways from this general curve, but it may be taken to represent the average child.[7]

Most abilities reach their highest points somewhere between the ages of 15 and 30 with the majority of them probably reaching their peaks between 20 and 25. In some individuals it is possible that some abilities like verbal comprehension, keep increasing for many years.

The Decline of Mental Ability. Fig. 21.12 shows the rate of decline of ability to do the Otis group test. Abilities are measured

in terms of test scores and not in terms of any absolute scale. Individual differences at every age are enormous, so that even at late maturity, from 10 to 25 per cent of the individuals may have scores higher than the average for those of middle age. The curve tells us only what to expect of the average person.

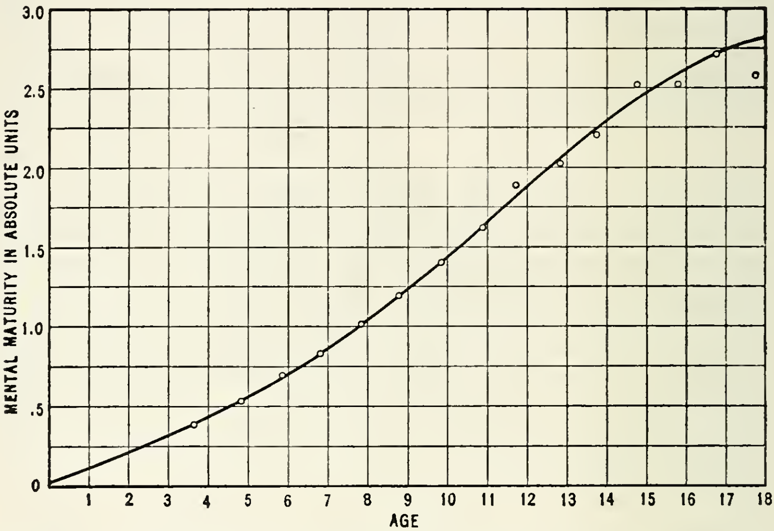

FIGURE 21.11. A curve of general mental growth when ability is measured in equal units on a scale with an absolute zero point. (Courtesy of L. L. Thurstone.)

Sex Differences in Ability. Before the days of women's colleges and of equal rights for women, it was taken for granted that women are intellectually inferior to men. The extreme lack of geniuses among women seemed to bear out this idea, with little thought being given to the fact that women were barred by custom from competing with men. Mental tests showed at once that girls are equal to boys, if not slightly superior, in the earlier years of childhood, and, on the whole, women are equal to men in mental-test rating.

Tests in Which the Sexes Differ. Although in almost every mental test the two sexes have decidedly overlapping distributions, in many of them the averages are different. Sometimes the average for males is higher, sometimes the average for females. The lists

given below are examples of tests and school subjects in which the two sexes show a consistent superiority.[8]

Males superior in:	Females superior in:
Arithmetic tests	Memory tests
Spatial-orientation tests	Verbal tests
Sustained logical work	Number-checking tests
Reaction time	Pattern-recognition tests
Speed of tapping	Speed of word association
Muscular strength	Mirror drawing
Muscular coordination	Quick adaptation and shift of attention
Dexterity with tools	Dexterity with fingers
History	Reading
Sciences	English
Mathematics	

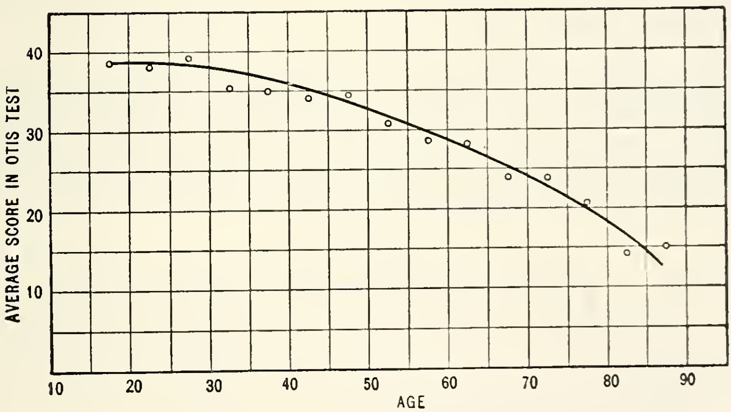

FIGURE 21.12. Rate of decline in general mental ability as indicated by scores on the Otis test. (From data of W. R. Miles in "The correlation of intelligence scores and chronological age from early to late maturity," *Amer. J. Psychol.*, 1932, 44, 44-78. (Courtesy of W. R. Miles and the *American Journal of Psychology*.)

Differences in Primary Abilities. Certain inferences can be drawn from these lists concerning sex differences in primary abilities. Boys and men have an advantage in the number ability, and also in visualizing and spatial orientation. Girls and women have the advantage in tests involving verbal ability, memory ability, and speed of perception. Among the motor tests, males have the advantage of strength, speed, and coordination, whereas women have the advantage of dexterity and quick adjustment to changing requirements.

We must recognize that factors other than abilities may enter into these lists of sex differences in tests and school subjects: motivation, interests, and opportunities for practice. The differences just cited should not lead one to conclude that they are caused by inborn, sex-linked characteristics, though some of them may be. Certain factors in our culture may be responsible for much of those differences.

Conditions in the Family. Whether the child is the first or last to be born in the family or is somewhere between in birth order makes little or no difference in his IQ. Neither does the age of his parents at the time of his conception and birth make any appreciable difference. The family conditions that are most clearly related to a child's IQ are the occupation of his parents and the size of his family.

Occupation of the Parents. In most tests, the higher the occupational level of the family the higher is the average IQ of the children. Table 21.5 gives perhaps the most dependable data on this question, based upon several hundred children of ages 2 to 18 who were given the Stanford-Binet test.

TABLE 21.5.—RELATION OF IQ TO OCCUPATION OF PARENT *

	Father's Occupational Classification	*Chronological Ages of Children* 2-5.5	6-9	10-14	15-18
I.	Professional	116.2	114.9	117.5	116.4
II.	Semi-professional and managerial	112.4	107.5	112.2	116.7
III.	Clerical, skilled trades, retail business	108.0	104.9	107.4	109.6
IV.	Rural owners	99.1	94.6	92.4	94.3
V.	Semi-skilled, minor clerical, minor business	104.3	104.6	103.4	106.7
VI.	Slightly skilled	95.1	100.0	100.6	96.2
VII.	Day laborers, urban and rural	93.6	96.0	97.2	97.6

* From Terman and Merrill.

The facts, of which those in Table 21.5 are representative, are undeniable. The explanation of these facts is a matter for further thought and investigation. One could say that the fathers gravitated into their various occupations because of their own levels of IQ; in other words, that the occupation of the father reflects his hereditary mental level, and that heredity is the determining factor of the high or low IQ's of his children. One could say, on the other hand, that the higher the occupational level of the

father, the greater the child's cultural opportunities and stimulation to develop, and that environment is the determiner of IQ in the child.

We may grant, for the present, that both heredity and environment are determining factors of IQ. Then we have the further responsibility of deciding which of the two is the more powerful determiner. From the facts in Table 21.5 alone, we cannot decide this question. But, since in all levels of occupation the average IQ remains fairly constant one would have to conclude that, if the environment changes IQ either upward or downward, it will have to get in its work in very early childhood.

Size of the Family. A large number of studies regarding size of family agree that the larger the family, the lower the average IQ of the children is likely to be. The correlations range from —.10 to —.40 in different studies, other conditions being held constant.[9] The more intelligent and better-informed parents voluntarily restrict the size of their families, whereas the duller and less-informed parents do not. This "differential birth rate" as it is called, has alarmed many alert citizens and surely calls for serious thought.

Racial and National Differences in Abilities. The study of racial and national differences in abilities is fraught with many difficulties and pitfalls. It leaves many of the answers inconclusive and open to different interpretations. The keen interest in the subject, however, has stimulated many investigations whose results give us some information of value.

Difficulties in Studying Racial Differences. One of the first difficulties is in determining what the genuine races are. Most races are complex mixtures, even the purest of them. Having decided upon some rather arbitrary groupings we must then obtain a representative sample of each population. A third problem has to do with the choice of test or tests with which to measure abilities. There is the fact that differences in language, education, social, cultural, and economic backgrounds often make comparisons of test scores questionable. We could, of course, simply take the test scores at their face values, and recognize racial differences in them. But we should never be justified in deciding upon fun-

damental or potential racial superiorities or inferiorities from those scores alone. It is those fundamental, if not innate, racial differences in which many are primarily interested. Differences as revealed directly by test scores are of some practical importance, and they are suggestive of more fundamental differences when interpreted intelligently.

How Different Races Compare in Psychological Tests. A very few of the many results from testing various racial groups will now be cited, with a word of interpretation where necessary.

(1) *The American Indian.* American Indian children who attend public schools speak English, and so are given the usual group tests and individual tests, like the Stanford-Binet. The average IQ varies from one tribe to another, but ranges from about 70 to 80. In non-language tests they do much better.[10] In performance tests the average IQ was found to be 97, whereas, for the same group in a verbal test, the average IQ was only 80.[11] In performance tests the Indian is much inferior to the White child when scored for speed. He cannot be made to see the importance of speed, especially when given an interesting task to do. When scored for errors, the Indian is approximately equal to the White individual. The decided difference between his ratings in verbal and nonverbal tests may be attributed to language handicaps. On the other hand, it may suggest a real inferiority in verbal ability.

(2) *The American Negro.* Two striking facts were shown about the American Negro who took the Army Alpha and Beta tests, along with the White men drafted into the Army. A brief comparison is given in Table 21.6. One result is the higher average scores in both Alpha and Beta for Whites, and higher averages for Northern than for Southern Negroes. To many people these facts mean a fundamental White superiority, and a tendency for the more intelligent, progressive Negroes to move northward.

TABLE 21.6.—COMPARISON OF TEST SCORES OF NEGRO AND WHITE MEN CONSCRIPTED INTO THE UNITED STATES ARMY DURING THE FIRST WORLD WAR *

Group	*Alpha Score*	*Beta Score*
White	58.9	43.4
Northern Negro	38.6	32.5
Southern Negro	12.4	19.4

* From Yerkes.[12]

Both conclusions must be discounted. Klineberg has shown that the Negro stock migrating northward is not superior to that remaining in the South, and that when the Negro child is given better school opportunities, as in New York City, the average IQ rises.[13] The longer a child lives in New York City, the higher his IQ becomes. Segregation of the Negro and less favorable home environment may be responsible for the fact that their average IQ is still below the average White IQ. It has been found that Negro children in northern cities may have exceptionally high IQ's; a girl with an IQ of 200 has been reported, and many with IQ's above 120 have come from pure Negro stock.[14] From these facts, it is clear that until we rule out the possible effects of inferior cultural opportunities, we cannot decide that the American Negro is fundamentally inferior in mental ability. The average difference under most favorable school conditions is, however, of some practical importance.

(3) *European Nationalities.* When children and adults of foreign extraction in the United States are given our standard tests, certain differences seem to stand out rather consistently. It is quite characteristic for the Jews and the descendants of northern Europeans, to stand high in the list when studies of this kind are made, and it apparently makes little difference whether verbal or nonverbal tests are employed. There may be a real difference in the abilities sampled by these tests that are due to heredity or racial stock. On the other hand, cultural differences in the home lives of these groups may account for the differences in test IQ.

(4) *Abilities of Oriental Races.* Tests of Chinese and Japanese children in the United States show them to be on a par with American children with respect to IQ's. The Japanese are somewhat lower than the Chinese and Americans in verbal tests, but they are inclined to do better than the Chinese in performance tests, and to exceed the American averages in tests of memory, thinking, and some nonverbal tests.[15]

The Physical Basis of Mental Ability. Since the human brain is relatively larger and better developed than that of other species, there has been some notion that within the human species larger brains go with higher intelligence. There is only a small grain of

truth in this idea. Within the White race, correlations between the skull capacity and estimated level of intelligence have been in the region of +.10 to +.15—almost no correlation at all. There is a very wide range of brain sizes among men of genius and also among the feebleminded. The most notable feature of brains of the feebleminded is the lack of abundant connecting fibers as compared with normal brains. A good blood supply is important and good nutrition for good brain functioning.

FIGURE 21.13. Two types of feebleminded children who show characteristic physical defects, a cretin on the left and a mongolian on the right. (Reproduced by permission from *Manual of Child Psychology*, by L. Carmichael, published by John Wiley and Sons, Inc., 1946.)

The thyroid gland is known to be a definite cause of lowered ability when it is defective. In a developing infant, seriously subnormal thyroid functioning is responsible for a condition known as *cretinism* (see Fig. 21.13). Along with mental retardation there is failure of physical growth, especially of bones, teeth, and hair. The feeding of thyroid extract early brings remarkable results physically and mentally. If the thyroid gland does not function sufficiently in adult life, a condition of *myxedema* occurs, in which the person becomes physically sluggish and mentally

dull. The feeding of thyroid extract improves this condition. There is no proof, however, that this treatment will make a normal person any brighter than he is.

Intelligence and Morality. There is a positive relation between intelligence and morals. In fact, after examining a large mass of data, Chassel came to the conclusion that for the population at large, the correlation between morality and intelligence is about +.70[16]

There are several logical reasons for this. The more intelligent can better foresee the consequences of their actions in advance. They are less likely to be poverty-stricken and thus are not forced into acts of petty thievery and the like. When they do commit criminal acts, they more easily escape detection and thus less frequently come to the attention of legal and social agencies. They are less likely to live in communities where examples of crime are set for them to follow. They more readily develop principles of good conduct on the basis of abstract ethical ideas. They more readily learn that in the long run honesty and virtue pay dividends.

Low Intelligence and Crime. In many studies, low intelligence is shown to be related to crime. Two examples will be given. Of 1690 inmates of penal institutions in Wisconsin, 30 per cent had IQ's below 75 and 50 per cent had IQ's below 90.[17] Of 969 inmates of Minnesota prisons, it was found that the criminals who were convicted and serving prison sentences were recruited in undue proportions from those with IQ's below 85 and in relatively small numbers from those with IQ's above 85.[18] Some other studies do not show the criminal to average so much below normal.

The picture for delinquents is much the same. In three of California's institutions for youthful offenders, 75 per cent were dull, borderline, or feebleminded, that is, with IQ's below 90.[19] Among 469 children committed for clinical examination, 33.7 per cent had IQ's below 70; 38.6 per cent between 70 and 90, and only 6.2 per cent above 110, the upper limit of normality. The median IQ of 3584 delinquents, aged 9 to 16, was 82.2.[20]

These are common pictures of the test intelligence of the youthful offender, but not all studies find as much mental deficiency among delinquent groups. It may not be low intelligence as such, that is responsible. The delinquent's low IQ may be merely a symptom of a whole network of circumstances that predispose him to crime. On the other hand, the low intelligence of his family and of his kind may lie behind the whole network of circumstances which some may blame for his crime. As to what the social remedy shall be is not a topic for discussion here. It is sufficient here to point out the correlation between low intelligence and crime, and to suggest the psychological connections underlying that correlation.

SUMMARY

Differences in human abilities in the general population are often unrecognized, ignored, or underestimated. Their importance for economic and social well-being is very great.

Psychological tests include an enormous variety of tasks that measure individual differences in sensory, perceptual, thinking, and motor performances. The first standardized tests with a mental-age scale were successfully prepared by Binet. From the known mental age and chronological age of a child, an index of brightness known as the intelligence quotient (IQ) is computed.

IQ's are normally distributed in most large, unselected populations. At one extreme are the rare bright children who are potential geniuses, and at the other are a like number of idiots and imbeciles. Half the population is within ten points of the average IQ of 100. Mentally dull children show handicaps of other kinds, in physical traits as well as in personality, whereas bright children are, on the average, physically and personally superior.

By means of a statistical device called correlation between pairs of tests, and another device known as factor analysis, psychologists are now discovering the primary abilities that enter into intelligence, which is now known to be a composite, as well as nonintellectual primary abilities. Individuals may be high in one primary ability, and high, average, or low in others. Some people

have high combinations in some or all of the primary abilities, and some are uniformly low in many or all of them. Measures of primary abilities offer improved information for use in vocational selection, classification, and guidance over that provided by an IQ alone.

General mental ability, as measured by intelligence tests, and the primary abilities taken separately, show development with age during childhood and youth, and decline after passing middle age. The peak of development in most abilities comes in the early twenties. There are some small sex differences, some favoring males and some females. A balance sheet would probably show that the two sexes are equal for general ability.

Conditions especially favorable for normal or better intelligence are: having parents in the higher economic groups; being a child of a small family; having a well-developed and well-nourished brain (not necessarily a large one); and a normal thyroid gland.

Racial differences in test scores are found rather consistently. The interpretation of these differences, however, is a difficult matter. No conclusion as to potential racial differences can be drawn with certainty at this time. The variation in ability within a race is much greater than is the spread of the differences between races.

In the general population there is a fairly high correlation between intelligence and moral behavior. Criminals and delinquents, as groups, have unusual proportions of members with subnormal intelligence. The causal relationships involved are exceedingly complex.

Questions

1. What would be some of the social and economic consequences if all men were created equal in mental ability?

2. Invent or find examples of tests of perception, memory, or thinking differing from those described in this chapter.

3. Given the following data, fill in the missing numbers in the table:

Child	Chronological Age	Mental Age	Intelligence Quotient
A	16	6	—
B	—	8	57
C	12	10	—
D	11	—	120
E	9	16	—

4. If a measured mental age depends upon the environment as well as upon the child's heredity, why should the IQ's of most children remain rather constant?

5. Many students have IQ ratings higher than the estimated IQ's of Washington and Lincoln, yet they will never attain the distinction of those two historical figures. Explain.

6. Assuming that one per cent of the population is definitely feebleminded, how many feebleminded individuals would you expect to find now in your home town; in your state or district; in your country? Give population data with your answers.

7. It is found that the correlation between intelligence-test scores and grades earned by the same students in college courses, usually lies between +.30 and +.70. What does this mean?

8. Which of the primary abilities would seem to you important for success in law; in playing football; in engineering; in piloting an airplane; in science; and in the study of languages? Explain.

9. If men and women are equal, on the average, in tests of intelligence, how can the sex differences listed on page 511 be explained?

10. What bearing does the relation of IQ's of children to the occupational levels of their parents have upon the question of heredity and environment as causes of differences in abilities?

11. Of the conditions mentioned in connection with human abilities in this chapter, which ones are probably causes, which ones are effects, which are both cause and effect, and which have no causal relation at all?

12. State some correct conclusions that can now be made concerning racial differences in abilities. State some propositions often expressed on this subject that are not as yet scientifically substantiated.

13. What would be likely to happen if the average IQ were raised to 110? If lowered to 90? (These questions assume the use of the present tests.)

14. Why is a feebleminded boy more likely to be found in an institution than is a feebleminded girl?

15. What in your opinion, should be done with the feebleminded criminal? The intelligent crook?

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CHAPTER XXII

Human Personality

What Is Personality?

Popular Views. Like many a term in psychology, the word "personality" has had a long popular usage. We must take special care to give it a strictly scientific meaning if we are to use it in psychology. One often hears the remark, "Now take Charles; there's a fellow with personality," or, "Sally may be all right, but she has no personality." The implication is that personality is something a few persons are fortunate enough to possess while others have to struggle along without it. Psychology takes sharp issue with this idea, for it recognizes that personality is something that every person has. Personality is not merely something that enables some people to gain favorable attention.

We also hear some people described as having "strong" personalities and others as having "pleasing" personalities. All these expressions imply an evaluation or an effect that the individuals have upon others and do not describe them as they really are. Since everyone has a personality, as we indicated above, if there are "strong" personalities, there are also "weak" personalities; if there are "pleasing" personalities, there are also "displeasing" ones; and if there are outstanding personalities, there are also those that do not attract much attention. But to say that personalities are "weak" or "displeasing" or "inconspicuous" is no more *descriptive* than to say that they are "strong" or "pleasing" or "outstand-

ing." In other words, to say that a person is pleasing or displeasing does not tell what he is like. It merely tells the effect he has upon you.

A Scientific View. The thing that gives individuals personalities is the fact that they differ from one another. If all people were exactly alike there would be no need of talking about personalities or personality. From one point of view, an individual is a bundle of characteristics or traits. But actually, he is more than a mere bundle, for the traits go together to form an integrated pattern when we view him as a whole. We may define personality as an *integrated pattern of traits.*

Personality Traits. This leaves us with the term "trait" still to be defined. Let us say that *a trait is any common, relatively enduring way in which one person can differ from another.* By "common way" we mean a way of differing found among people at large; not an isolated peculiarity belonging to one person and to him alone. This makes personality a very inclusive concept. It would include physical characteristics as well as behavior traits. It would include mental abilities as well as temperamental qualities.

From the psychological point of view, our primary concern is with differences in behavior. Differences in abilities have already been treated in the chapter just preceding. There is left to us the question of how people differ in their *manner* of behaving. There is no satisfactory term to include all the traits of behavior not covered in the mental abilities. Many psychologists use the term personality in this limited way. But there seems no good reason for restricting an individual's personality this much. Certainly, what the individual is like, as compared with other persons, includes his talents and defects.

Temperament. The term *temperament* is often used to include all of an individual's emotional traits and it is properly so used. But this does not take in all the traits of behavior not described under abilities.

Character. The term *character* has a moral or ethical significance. We may say that character traits are those traits of behavior that have acquired a moral evaluation. Traits such as nervousness,

sociability, or flexibility can hardly be called right or wrong; people cannot be blamed or praised for them, in our present culture. But traits like cowardice, honesty, and cruelty have an unquestioned moral aspect under our present code of ethics. They are considered as traits of character, although at the same time, of course, they are also traits of personality, for they represent ways in which people differ.

Interests and *Attitudes* are also types of personality traits. They were discussed in Chapter VIII, so will receive only limited attention here.

Problems of Personality. The psychological problems of personality are many. From the theoretical standpoint, we need to know what the significant traits are, how they are related, or how they go together to form the pattern we call the individual personality. We also want to know how traits of personality develop; how an individual becomes the personality that he is. If we happen to be interested in changing individual personalities, our interests will, of course, lie in ways of studying persons and the means by which we can alter them for the better. Our methods will naturally differ according to our special interests and what we propose to do.

How Personalities Are Measured

Dimensions of Personality. Every personality trait implies a difference between people. Every difference implies a direction; toward laziness or away from it, toward impulsiveness or toward caution, toward accuracy or toward inaccuracy, to give a few examples. Almost every behavior trait (except abilities) has its opposite, and the two opposites can be thought of as lying at the two ends of a straight line. A straight line suggests distance, with intermediate positions along the line. And distances suggest measurement.

It is obvious that if we speak of impulsive persons we do not mean that they are all equally impulsive, and if we speak of cautious people we recognize that some are more cautious than others. So we may arrange people whom we know along the line that extends from extreme cautiousness to extreme impulsiveness. Somewhere between the extremes would be an indifference point

where we would place many people. We could not call them either generally cautious or generally impulsive.

A scale such as this, along which individuals may be arranged, we call a *dimension of personality*. It is an abstract idea, naturally. No one ever saw a dimension of personality in concrete form. It is simply a symbolic scheme which we introduce to help us obtain a scientific grasp of personality. The number of dimensions that one could think of, with opposite characteristics at the ends of a scale, would be very large. Many of them are very similar in meaning, for example, courageous—cowardly, and bold—timorous. We could have a fairly good picture of a person if we knew where he ranks on a large number of these dimensions. But since so many of them are nearly alike, our description would contain much useless duplication. It is one problem of psychology to reduce the number of dimensions needed to describe persons to the smallest workable number.

But, for the present, we are interested in methods of placing individuals on the various dimensions. We begin by selecting dimensions that seem from general observation to be significant and real. We then set up devices for indicating what position each person occupies along the line. The methods of measurement, for the most part, can be classified under three headings: (1) rating scales, (2) tests, and (3) questionnaires or inventories.

Rating Scales. A good observer of persons naturally develops some rough ideas of where they stand on different dimensions of personality. We habitually make mental notes like the following: A is extremely conscientious. B is bolder than C. D is the lowest kind of cad. E is not the most fickle person I have ever known, but he is high in the list. To make our ratings systematic we can apply here the methods of pair comparisons and of rank order that were described in connection with judging likes and dislikes (see Ch. VIII). In this instance, however, we are judging people; we are not simply reporting how much we like them or dislike them, and we have to keep in mind the particular quality or qualities to be rated. To give the raters a clear idea of the meaning of the dimension, we must take great pains to define the two opposite

traits clearly. The following graphic scale for rating persistence is a good illustration.

Rating Scale for Persistence*

Definition. To persist is to continue trying to accomplish a task in spite of difficulties; to cling to a purpose in spite of counter influences, opposition, or discouragement. This applies to everyday tasks as well as to more remote goals.

Direction. Mark with an "x" the position on the line that best describes your own degree of persistence. (Your mark need not be immediately above one of the descriptive phrases; it may be at any point along the line that you think best fits you.)

Extremely persistent. Perseveres in spite of difficulties. Never gives up.	*Seldom gives in to difficulties.*	*Usually finishes a task before leaving it.*	*Tends to leave difficult tasks unfinished.*	*Extreme lack of persistence. Easily deterred by obstacles. Gives up quickly.*

Some Common Errors in Rating. Much experience with rating scales over a period of years has shown where their good points and their weaknesses lie; where they can be used with good results and where they cannot be used. Only a few of the more common errors will be mentioned here.

(1) *The Halo Effect.* Every person wears one or more psychological halos. That is to say, others are likely to have *general* impressions of him that are good or bad, high or low. A general level may be established by one or two striking qualities or traits that stand out or cause others to like or dislike him. Or it may be established as a kind of average of all his observable traits. However it came about, the general idea of him influences a judge who attempts to rate him on any particular trait. If the general impression is high or favorable, he is rated too high on most traits; if the general impression is low, he is rated too low on most traits. All ratings are distorted in the direction of the level of the general impression.

* After Thornton. The scale can also be used for rating others.

(2) *The Error of Leniency.* Most raters are inclined to rate their friends and acquaintances too far in the direction of the favorable ends of the scales. The mere fact that you know a person, and are favorably disposed toward him, biases you in his favor, especially if he has something to gain by your so doing, or if you suspect that he may find out how you rated him. Even though you are not favorably disposed, your sense of fair play may temper your judgments of him when you know those judgments may matter. The error of leniency is most apparent in self-ratings. As would be expected, the individual tends to overestimate his good qualities and to underestimate his poor ones.

(3) *The Error of Caution.* Most raters are inclined to place other people nearer the center of the scale than they should be. There are two possible causes of this. If you are somewhat in doubt about another person, you hesitate to place him near either extreme of the range so you protect yourself and him by keeping him close to the center.

Who Are Good Judges of Personality? Not every observer makes a good rater of traits in himself or in others. We can check up on any rater by comparing his ratings with the average ratings obtained from a number of other judges. Such tests show certain consistent factors that make good raters.

A good judge is, first of all, one of maturity, if possible past the age of thirty. A rich background of human experience in various aspects is highly desirable. High intelligence is another requirement, especially in rating one's self or in rating casual acquaintances. Insight into one's own shortcomings and prejudices and a sense of humor are also important, in fact they are essential in the good judge of self. Curiously enough, a sociable, good-mixer type of person is not as good a judge of human nature as the unsocial, detached observer. Sometimes women raters are found to be superior to men, as common opinion of women's "intuition" would have it.

Personality Tests. Tests of behavior traits have not been so successful as tests of abilities. It takes much ingenuity to devise exactly the right kind of standard situation in which the subject taking the test can show where he stands, with regard to some trait

we are trying to measure. A great many tests have been invented, however, and a few of them are rather promising of future success. The tests fall into two arbitrary classes: (1) performance tests, and (2) verbal tests.

Some Performance Tests. Performance tests are the ideal type of personality test, for they duplicate more nearly everyday life situations. If we are trying to measure a person's place on the scale of persistence, for example, we have to set up in the laboratory, or clinic, situations that will call forth a subject's characteristic effort. In most cases the real purpose of the test has to be concealed from him, because if he knew which dimension was being measured, he could probably behave in the manner to show much of the desirable trait. If we were testing a subject's honesty and had given him opportunities in the test to lie, cheat, or steal, he could undoubtedly refrain from doing so. If the opportunities for dishonesty seem to come incidentally, and as a by-product of the test, he might react very differently.

In one test of honesty, in a natural classroom situation, a test in spelling or in arithmetic is given. The children are permitted to correct their own papers on the following day, but in the meantime their real errors are recorded. A child's score for dishonesty lies in the number of surreptitious changes made in his scoring of his own paper. In another test of honesty, the children are given a small supply of coins, ostensibly to be used in an arithmetic test. When the coins are collected, the amount missing serves as an indicator of honesty. Tests permitting opportunity for overstatement or other forms of falsehood attempt to measure another phase of honesty.

In a test of persistence, the subject is told that he is being tested for motor control, in throwing darts at a target. First, he is given a practice period, in which he may keep on rehearsing the test as long as he likes. The length of time he will voluntarily stay at the practice is the measure of his staying qualities. One must be careful here to arouse about the same desire to win or to excel in the final test, and to be sure that the subject has plenty of time at his disposal for the practice he feels he needs. It is also desirable that the task be equally demanding in practice. Even then we have not controlled the factor of self-confidence or feeling

of need for practice. This particular test has not proved to be a particularly good one, but it is cited to illustrate the many things which the tester has to try to keep constant, and the many difficulties that beset his path.

Tests of endurance are somewhat better controlled. One gives the subject a strong discomfort or pain, for example, by pressing a blunt wooden peg into the back of his hand, increasing the pressure as time progresses. The subject is at liberty to say "Stop" at any time he wishes, and the painful stimulus is removed immediately. The length of time he will endure the pain and discomfort indicates his "staying quality" and is taken as a score for endurance. In another test the subject is told to draw a deep breath and to hold it just as long as he can. The length of time he will hold his breath against a growing discomfort is again taken as an indicator of endurance.

A Verbal Test. In a somewhat different test, designed to measure persistence, the subject is given a passage of reading material that begins rather easily, but, as he progresses, becomes more and more difficult, until it is well nigh impossible. Samples from such a passage read like this: *

"Murder is seldom pleasant," the tall Westerner replied dryly; "but," he continued, figuring his cigarette lightly, "sometimes it is necessary."

who knows?here sponded witha carel ess shrugof thes houl ders someth in gin his man ner told me th at it was fu tile to saymore

Ed Frie ndm I lice nth asa tt end edtoe Ve rym a tte. R wed in E.M. on d a yats eve nath. O! tell enn ox.

Rea sedann Uni tys, "O ldl 89, latl etu S.S.", ayf rie ndab; sol Ut el ys h †

Questionnaires. Questionnaires, or personality inventories, ply the individual with a large number of crucial questions, which he is usually to answer by saying "Yes" or "No." Often a third alternative, a question mark, is offered. Examples of such questions follow:

* From Thornton.

† The key to the last sentence will be found on page 532.

In an argument do you find it difficult to give in?....Yes ? No
Are you usually insistent in getting exactly what you want? ....Yes ? No
Do you get tired of work quickly? ....Yes ? No
Are you ordinarily a carefree individual? ....Yes ? No
Are you inclined to keep in the background on social occasions? ....Yes ? No
Are you easily disturbed by distracting stimuli while doing mental work? ....Yes ? No
Are you inclined to rush from one activity to another without pausing for rest? ....Yes ? No
Can you relax yourself easily when lying or sitting down? ....Yes ? No
Are you inclined to be overconscientious? ....Yes ? No
Are you usually concerned about the future? ....Yes ? No

Every answer is taken as an indicator of something about the person who gives that reply. As a measuring instrument, a large number of questions that are aimed to indicate the same dimension of personality are put together. For example, one inventory designed to measure persistence, included about a hundred questions similar to the first three in the list given above. The questions are designed to cover a wide variety of situations in which the trait is thought to appear, or a variety of ways in which it can manifest itself. The score may simply be the number of answers "Yes" or "No" that seem to indicate the same end of the scale, either persistence or lack of it.

Some Limitations of Personality Inventories. It is often stated in criticism of personality inventories that the person who is asked the questions does not know himself well enough to answer them correctly. It is also often stated that individuals answer the questions not as they know they are but as they would like to think they are or as they would like others to think they are.

There is enough truth in both of these assertions to invalidate the scores under some circumstances, as when some intelligent

* The last sentence of the persistence test on p. 531 really does not make a sentence. One solution is merely a series of words: "Rea Sedann Unity sold 1891 at let us say friend absolutely sh.

people take an inventory in order to qualify for a coveted appointment. There are some corrective features for these difficulties, however. Questions are usually stated so that the reader with at least grade-school achievement can understand them. They usually refer to personal habits that almost anyone has had much opportunity to observe in himself. Since they refer to personal habits, preferences, or opinions, they do not obviously give away what traits the psychologist is attempting to measure. This makes it less easy for the average person to bias his score successfully. With some inventories there have been developed secondary scores or other signs as to how sincere the individual has been in answering the questions.

In spite of these safeguards, however, inventories must be used with caution. One can feel the most confidence in the meaningfulness of the scores when the individual has no special reward to be gained by making a good impression, and when he sincerely wants to know just how he stands on the traits measured.

Projective Tests. A relatively new class of instruments developed for the assessment of personalities is that of projective tests. The first, and probably the best known, is the *Rorschach* inkblot test, invented by a Swiss psychiatrist of the same name. A series of ten large and somewhat complicated inkblots similar to that in Fig. 22.1 was prepared. You hand a card to the examinee saying, in Rorschach's terms, "What might this be?" The way is left open for the examinee to say whatever the picture suggests to him.

Since the picture itself is highly ambiguous, the examinee's perception of it is determined to a very large extent by his own mental nature—his desires, biases, worries, hostilities, etc. He is usually unaware of the motivation that prompts his responses. The psychologist must interpret the examinee's responses, being guided by the experiences of many who have used the test as well as his own experience. He is guided not so much by the things named as by what aspect of the picture prompted them. Some examinees tend to name objects representing the picture as a whole, while others tend to analyze it, naming details, sometimes very fine details. Some responses are prompted more by the colors (about half the cards have colors other than blacks and whites)

and some more by the forms. Some tend to see objects only as stationary while others see some objects as if moving. Some tend to name objects made out of the white spaces between the inked areas. All of these tendencies are presumed to have meaning concerning the examinee's personality.

FIGURE 22.1. An inkblot such as is used in the famous Rorschach Inkblot Test. What do you see in it?

Another well-known projective test is Murray's *Thematic Apperception Test,* or *TAT.* The material in this one is in the form of pictures, showing people in somewhat ambiguous situations. The pictures have been so selected that the examinee can identify himself with one of the persons in the picture. He is told to make up a short story about the picture, telling how the situation came about and what the outcome will probably be. In interpreting the results from this test, most attention is paid to the

content of the story and what it shows about the desires and frustrations of the examinee.

Some Limitations of the Projective Methods. The projective techniques have gained considerable vogue in clinical psychology. They have the advantage that the examinee does not feel restricted as he does in answering items in other tests and inventories. Though, as in the case of inventories and self-ratings, he may hold back some responses that seem self-derogatory, he is much less likely to know when a response is either favorable or unfavorable to him.

A projective test is undoubtedly useful in understanding a patient in the clinic. But even for this purpose, the use of projective methods has been promoted far in advance of the careful research needed to justify it. For the purposes of vocational selection, classification, and guidance, projective methods are as yet definitely inferior to other procedures.

The Structure of Personality

Consistency in Behavior. The only reason why we can speak of a person as having any enduring behavior trait is because he shows some degree of consistency in his actions. If we say of a man that he is honest, it is because we have found him repeatedly honest when he had opportunities to be dishonest. Even if he did not react honestly in 100 per cent of the cases. we might still rate him higher than another person who is honest a smaller percentage of the time.

Consistency in Test Behavior. When people are studied systematically in test situations, their degree of consistency can be better observed. In a study of honesty in a large number of school children, where tests permitting lying, cheating, and stealing were used, a surprisingly small degree of consistency was found. The correlations between the different test scores were rather low, although they were positive. The average coefficient was about +.30. From this result it is plain that when a child scores as honest in one situation, you cannot tell very much whether or not he will be honest in another.

Are Habits Specific? This conclusion about honesty of children has been hastily generalized to mean that all behavior is rather specific and depends upon the immediate situation rather than upon some enduring qualities or mental sets of the individual. It has been urged that there are no general traits at all; only specific habits attached to specific situations. If a child seems to be consistently honest, it is because he has been trained to react in the honest way in a number of situations.

This generalization has several faults. In the first place, it ignores the fact that in traits other than honesty there may be more actual consistency. We may grant for the moment that individuals do not have any general set to be honest, forcing them to behave in an honest way in a variety of situations. This need not mean that they could not show a high consistency in some other traits, like sociability or nervousness. Experience with ratings of traits bears out this idea. When rating people on one trait, judges may agree rather closely; in rating them on another trait, they may disagree a great deal. There is simply greater consistency of behavior reflecting the one trait than there is reflecting the other.

Another weakness of the generalization is that a general set for honesty has to be developed in each individual. It grows something like a concept. The child is taught to be honest in specific situations, one after another, but he learns more than that. He generalizes, and his training transfers to similar situations. He links up one kind of honesty with another, until a verbal concept is formed. He is taught honesty as a principle. Any abstract concept like honesty or virtue requires a certain maturity before it can appear. Little wonder that school children are not consistent in tests of honesty. We might expect more consistent individual differences in this same group as they grow into adults.

Traits Differ in Generalization. Traits of behavior differ very much in scope. Nearly every learned response, even the simple conditioned response, becomes generalized to some extent. But we should hardly call a conditioned response a trait. A certain person has a conditioned aversion that extends to all kinds of cheese. Shall we say that he has a cheese-hating trait? Hardly, for two reasons. In the first place this characteristic is too limited

in scope, and affects a very narrow range of his behavior. In the second place, although he does differ from other people in this respect, it would hardly be significant to line people up on a dimension of "hating cheese" versus "loving cheese." If conditioned responses were generalized enough to permeate and color a large range of action of people at large, we might find it necessary to recognize a new trait.

Many generalized habits do actually permeate the behavior of people at large, for example, the habit of advancing toward versus retreating from social contacts. One person, you find, greets you very cordially, is chummy and confidential rather than reticent and diffident, strikes up conversations easily with strangers, and makes new friends easily. Another is the opposite in every respect. Still others are somewhere between these two extremes. Since so much behavior is colored by this way of meeting people, and since everyone stands somewhere with respect to the advancing—retreating scale, we certainly must recognize, here, a trait or dimension.

Still other characteristics are even more extensive and pervasive. They color not only social reactions but all kinds of reactions. Take nervousness, for example, or ambition, or other characteristics that may flavor all that one does. It would seem, then, that an individual's characteristics rest upon properties of behavior that differ in generality all the way from specific conditioned responses to those so broad in scope as to include all his actions. When characteristics become generalized enough and common enough to be recognized in people at large, we call them traits. Traits, too, differ in their scope, that is, in the range of actions that they color. The causes of traits will be discussed later in this chapter.

Statistical Analysis of Personality. A diligent search of an unabridged dictionary reveals almost 18,000 separate terms that can be used in describing people.[1] This represents about 5 per cent of our entire English vocabulary. It is a gold mine for those who have the literary bent and wish to describe personalities in a rich and colorful manner. It is entirely too long a list for the purposes of scientific description. Science works under the dictation of the motive of economy. It strives to reduce all descriptions to the smallest number of useful terms.

We have already seen that when personalities are measured, the result is to place them at definite positions on one or more dimensions of personality. It was also pointed out that many of the dimensions, whether rated, or tested, or measured by questionnaire scores, were overlapping, and therefore they duplicate our labor. The ideal would be to find a system of dimensions that are independent or nonoverlapping, and yet that cover the significant aspects of personalities as we know them and can measure them. In the case of mental abilities, instead of naming as many human abilities as there are tests, we found that a limited number of primary abilities could be discovered by a method known as *factor analysis*. The same method is enabling us to make advances in reducing our description of other aspects of personality to a simple, economical system. This system is composed of what we may call primary traits.

Personality Types. In dealing with personalities in a practical way, the average person tends to pigeonhole the people he knows into separate and distinct classes. Each person is likely to have his own pet scheme of classifying human nature. He sees the need of a scheme or system, but he grasps at whatever scheme is suggested to him or appeals to him at the moment, and he revises it when it fails to work. Such a scheme is very useful if it will work. Knowing just what to expect from a person of any "tribe," and having placed any newcomer into one of the "tribes," we can be more at ease, for he is no longer an unknown quantity.

Introverts and Extroverts. Many serious students of human nature have taken a similar approach to the treatment of personality, and we have seen one scheme after another proposed for general acceptance. Most of them have come from psychologists or psychiatrists of wide experience, but the selection of "pigeonholes" has usually been made on the basis of armchair reflection, after general, though extensive, observation. The result has been a number of simple classifications of people into types. The best known types are those proposed by the psychoanalyst, Jung, namely, *introverts* and *extroverts*. As in most of these schemes, two opposite types were thought to encompass all humanity. If

this were true, it would be a very simple matter to separate your friends and acquaintances into one class or the other.

As first proposed by Jung, the introverts are people whose interests are turned inward upon themselves and their own thoughts, whereas the extroverts are those who interests are turned outward upon the environment. In America, a strong social flavor has been added to the terms. Accordingly, the introvert shuns social contacts and is inclined to be reclusive, whereas the extrovert seeks social contacts and enjoys them. An emotional responsiveness that is obvious to the outside observer has also been attributed to the extrovert, whereas the introvert is supposed to be not very expressive. A few of the characteristics attributed to extroverts and introverts are summarized in Table 22.1.

TABLE 22.1.—SOME CHARACTERISTICS OF SO-CALLED EXTROVERTS AND INTROVERTS

Extrovert	*Introvert*
Alert to his environment	Absent-minded; daydreams
A good mixer	Shuns social contacts
Has ups and down in mood	Apparently even tempered
Expresses emotions readily	Not expressive of emotions
Impulsive in action	Thinks things over before acting
Likes action	Likes reflection
Likes change	Dislikes change
Adapts readily	Not easily adapted

What Is Wrong with Personality Types? Most theories of types have failed to stand up under close scientific scrutiny. In the first place, the idea of pigeonholing people into separate and distinct categorists has always run counter to the general laws of individual difference. When tests and scales have been used to measure introversion and extroversion, almost invariably it is found that the population does not fall apart into two blocks of humanity as the type theory would require (see Fig. 22.2). No matter what the test, we find that there seems to be a tendency for populations to follow the law of normal distribution, as shown in Fig. 22.2. About half the people would rate as neither extrovert nor introvert, but as lying in between. They have been called *ambiverts.* We have, therefore, not a sharp division of personalities into types, but a continuous dimension. In this case the ex-

tremes may be called introversion and extroversion, but there are all degrees of either one.

A second objection to types, and to introversion and extroversion in particular, is the question whether, in reality, they represent a single, primary dimension, or whether they are complex patterns of several primary traits. The answer is to be found in factor analysis. Remember that factor analysis begins with the correlations between tests or measurements. We could, for example, take the list of characteristics given in Table 22.1, secure

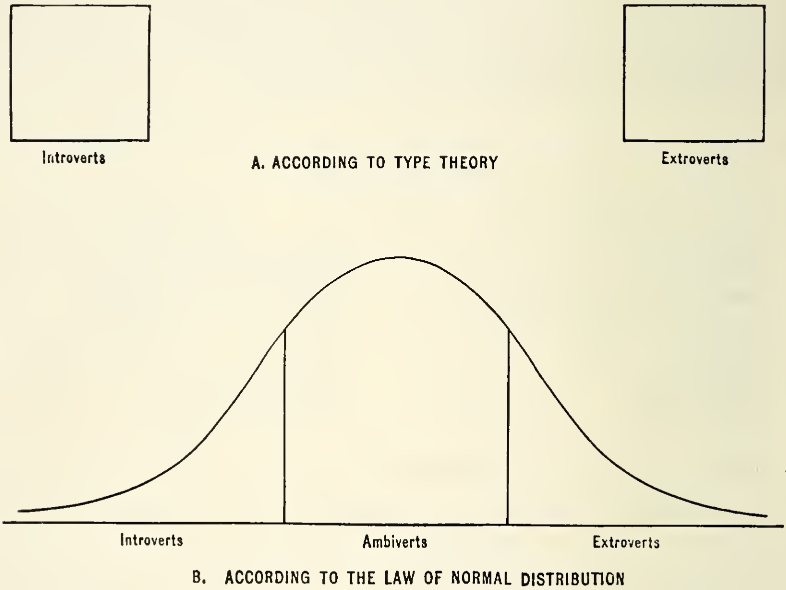

FIGURE 22.2. Diagrams showing in contrast the distributions of a population as to introversion and extraversion, according to the type theory (A) and according to the general principle of normal distribution (B).

ratings of several hundred persons on every one of them, then compute the amount of correlation between every pair of items. Then we would look for clusters of items that had high correlations among themselves but low correlations with others. We have said that behavior traits represent consistency of action. The cofficient of correlation between two ways of behaving is simply a measure of their degree of consistency in the typical person. Thus, in factor analysis, we are really finding consistencies in

behavior, statistically verified, rather than merely decided by general observation and armchair reflection.

Some analysis has already been made, not only with the items in Table 22.1, but also with others like them, and with still others not thought to be related to introversion-extroversion. It was found that what we have called introversion-extroversion is really a composite of several primary dimensions, just as intelligence has been found to be a composite of a number of primary abilities.

Some Primary Traits. The number of primary traits that exist in personality is probably very large, although those of greatest social importance may not exceed a score in number. A few that have already been discovered will be mentioned as examples. This list is still far from complete. With each primary trait are listed some of the characteristics from which the trait derives its name.[2]

(1) *Shyness.* This is the strongest trait or dimension represented in most questionnaires of introversion-extroversion. Some of the characteristics that indicate it are:

Inclined to stay in the background on social occasions.
Inclined to limit acquaintances to a select few.
Does not enjoy getting acquainted with most people.
Inclined to keep quiet when out in a social group.
Dislikes to speak in public.
Prefers not to take the lead in group activities.
Finds it difficult to start conversation with strangers.

The opposite pole of this dimension is to be described by the opposites of the characteristics just given. It is not so easy to name. The dimension is best described as "social approach-withdrawal," and the more familiar terms "sociability" and "social interest" come fairly close in naming the opposite pole.

(2) *Reflectiveness.* There is a general habit of proneness to meditative or reflective thinking as indicated in the following items:

Is introspective; analyzes himself.
Often in a meditative state.

Analyzes the motives of others.
Likes to discuss serious questions of life with his friends.
Is philosophically inclined.

This trait perhaps comes closer to Jung's original idea of introversion than does any of the other primary traits you see mentioned here. The extroverted pole of this dimension is best described as disinclination to reflectiveness.

(3) *Depression.** This is a clear-cut trait also found represented in questionnaires on introversion-extroversion. Some of the indicators are:

Has periods of loneliness.
Frequently in low spirits.
Easily discouraged.
Worries over possible misfortunes.
Frequently in a meditative state.
Frequently feels grouchy.

The opposite pole of this dimension should be described as cheerfulness. This pair of opposites is very close to the popular pair of optimism and pessimism.

(4) *Emotional Instability.* This trait is often found measured by inventories of introversion-extroversion, but it is practically unrelated to other dimensions such as shyness and reflectiveness. A person standing near this end of the scale says he has the following characteristics:

Changes from happiness to sadness without apparent cause.
Has frequent ups and downs in mood.
Expresses emotions readily.
Often craves excitement.
Worries over possible misfortunes.
Daydreams.

---

* It will be noted that often these primary dimensions are named for the less desirable extreme, as in this case. The reason is that that extreme is easier to name with a single term, or the indicators pointing in its direction are more definite or striking qualities of persons.

This is also sometimes known as the cycloid disposition because of the marked tendency to swing from elation to depression. In other words, the emotionally unstable person's moods tend to go through cycles. But there are other signs of instability, and the cycles are not necessarily rhythmical. The opposite pole is one of emotional stability or placidity.

(5) *Rhathymia.* You might expect to find the qualities of "happy-go-lucky" and "carefree" exactly at the opposite pole of the primary trait of "depression." Such is not the case. Statistical analysis shows them to be at a pole of a quite distinct dimension opposite from the quality of self-restraint. There is a strong element of irresponsibility or lack of concern that distinguishes "carefreeness" from cheerfulness or happiness. The term *rhathymia* (rath-uh-me′-uh) has been coined from the Greek to give this turn to the trait name. Cattell calls it "surgency." Some indicators are:

> Is a happy-go-lucky individual.
> Is ordinarily carefree.
> Does not stop to think things over before acting.
> Is impulsive.
> Often craves excitement.

By this time it should be noted that the same indicator may appear under more than one primary trait. This situation is reasonable. The person who says he "craves excitement" may do so because he is happy-go-lucky or because he is of the moody, cycloid disposition. The shy person says he "stays in the background on social occasions"; and so does the depressed individual, but for a different reason. In other words, the same habitual action may be an indicator of two or more different traits. This is one reason why direct observation of traits so often leads to confusion and overlapping classifications.

(6) *General Activity.* The best indicators of this are:

> Is quick in his actions.
> Can turn out much work in a short time.
> Rushes from one activity to another without pausing for rest.

Is talkative.
Hurries to get places even when there is plenty of time.

(7) *Nervousness.* A person lying toward the "nervous" end of this scale has the following characteristics, or at least reports that he has them:

Is easily disturbed by distracting stimuli while doing mental work.
Cannot relax easily when lying or sitting down.
Is easily startled by distracting stimuli.
Suffers from insomnia.
Uses up more energy than the average person in getting things done.
Has nervous habits, for example, biting finger nails.

These few examples of primary traits will suffice to illustrate how many seemingly isolated characteristics may be brought together and reduced to a few primary traits which underlie them. It also illustraes how seemingly fundamental traits, or types, selected as real and simple, turn out to be complex when statistical analysis is applied to actual data. It is being found that such popularly accepted traits as self-reliance, for example, can be broken down into a number of others, just as introversion-extroversion has been.

Primary Traits in Persistence. The popular trait of persistence, also, has been found to be a composite of two primary traits. Recall that we defined persistence earlier in the chapter as a tendency to "continue trying to accomplish a task in spite of difficulties; to cling to a purpose in spite of counter influences, opposition, or discouragement." In actual performance tests where this quality should have appeared, it was found that the ability to endure pain or discomfort in pursuing a task was something quite separate and distinct from mere keeping on, or as we should more accurately say, plodding. A person might be a good plodder and keep working at a task set for him, but he might not necessarily endure pain or discomfort to do so. On the other hand, a person might stand much pain or discomfort and still not carry a task to its conclusion.

Primary Character Traits. A few pages back we were told how the many tests of honesty as administered to hundreds of children gave low intercorrelations. We also saw how, from this, the conclusion was erroneously drawn that honesty is not a single thing but a number of specific habits of being honest.

But the correlations, although low, were generally positive. Any correlation at all between two tests means that they have something in common, no matter how small that common component is. A factor analysis was made of the tests along with other tests of cooperation and unselfishness. A general trait seems to permeate all these tests. It is best described as a tendency to forego immediate gains or gratifications for the sake of larger future goals.[3] Such a trait indicates that there is some very broad mental set operating to control the conduct of the children as they take these tests. Since the intercorrelations were all relatively low, it means that this set was a rather small determiner of conduct in these young children. Presumably it would become a much stronger determiner of differences in conduct as they grow older.

Another general trait of character that has been suggested is the tendency to forego personal gratifications for the sake of larger social gains. The two traits may seem related, but there could be much independence. Thus, the thing we popularly call character is also subject to statistical analysis. From such an analysis we may be able to help decide what the real determiners of moral conduct are, how rapidly they develop, and why they fail to develop.

Primary Interests and Attitudes. Interests and attitudes have also been subjected to statistical analysis in some preliminary studies. To give a few examples, some of the primary interests are in science, in people's welfare, in outdoor athletics, and in religion. Instead of one aesthetic interest, as might be expected, there are two: in the enjoyment of artistic things and in the production of them. The two are probably correlated. It is easy to think of individuals who have the first but not the second. But it is difficult to think of individuals who like to produce art but who do not enjoy the product.

Some of the better established primary dimensions of attitude include: radical-conservative, rational-sentimental (or hard-boiled-emotional), and democratic-autocratic (belief in personal liberty

versus belief in coercion). It takes little reflection to recognize the importance of these attitudes in our social, political, and economic life. National differences in them, as well as smaller group differences, are continual sources of conflict.

Personality Profiles. We can obtain scores for an individual in each of several of the primary dimensions. We could, for example, conclude that Bob is extremely bold socially (not shy), not very much inclined to thoughtfulness, on the cheerful side, and very happy-go-lucky. Taken together, these facts give us a more meaningful description of Bob than when we consider each trait alone. In other words, it helps to note the *pattern* of scores for a person.

A very useful device providing such a picture of an individual is a *profile* like that shown in Fig. 22.3. In that diagram we have not only the profile of a given person but we also have shown the regions at the various trait columns in which experience has shown the more favorable scores for supervisory personnel to be. To the extent that this person's scores fall within those regions his personality pattern conforms to that of successful supervisors, at least so far as these particular personality dimensions are concerned. Similar profiles can be drawn for abilities, interests, and attitudes. All we need is a method of translating scores obtained from different tests or inventories into numbers on a common scale.

Conditions Related to Personality

What makes personalities what they are? We have seen that personalities can differ in a multitude of ways. The causes that determine those differences are just as numerous, if not more so. We found that it is possible to describe individual differences in behavior traits in terms of a reasonable number of primary dimensions. We shall also find that a relatively small number of conditions will include the important causes of those differences.

Different Causes for Every Trait. The discovery of the causes of a given trait is not easy. There is usually no single cause of shyness, or nervousness, or of any other trait or characteristic.

One person may be shy in social situations because of some hereditary disposition which acts either directly or indirectly as a determining factor. Some infants exhibit such a trait at a very early

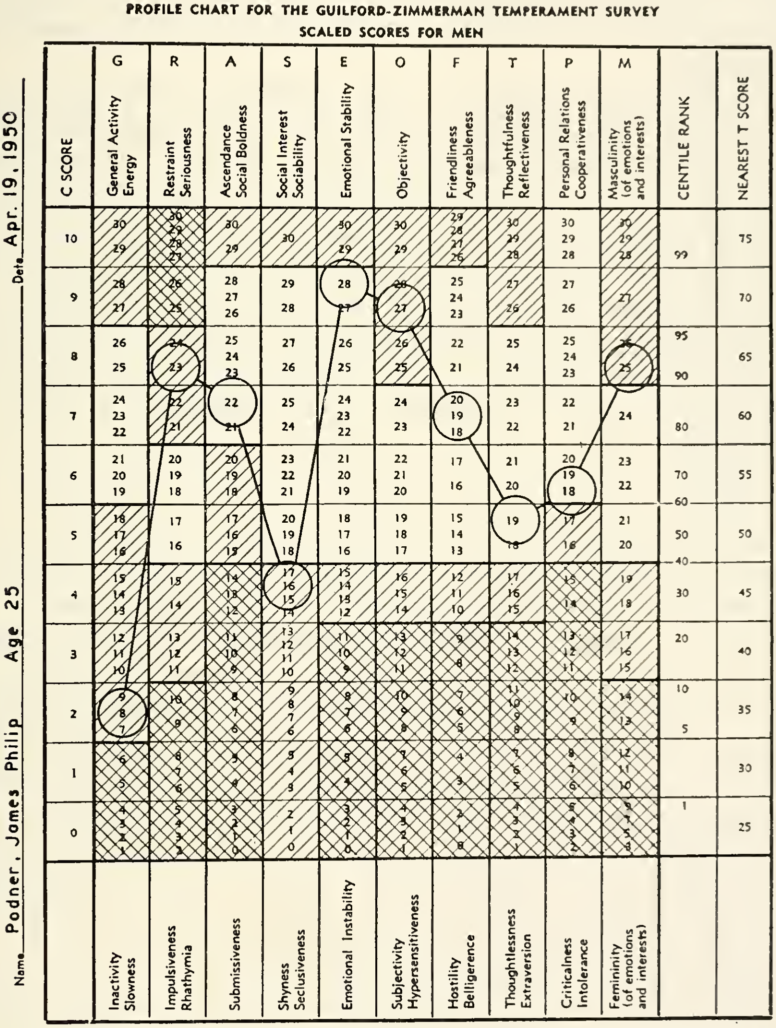

FIGURE 22.3. A profile chart, showing the variations in score level of one individual in the ten traits measured by the "Guilford-Zimmerman Temperament Survey."

age without any apparent need for it or without any training in that direction, while others do not. The possibility that at least *some* individuals have in their hereditary constitution a bent in the

direction of shyness is not by any means excluded. An indirect hereditary factor for shyness might be a physical defect that earns for the individual only unfavorable social reception. At every turn social contacts are found unpleasant, and so withdrawal and retreat become the consistent response, and a trait of shyness is confirmed.

Other factors, purely social and accidental in character, may make social contacts generally unpleasant. The neglected child, the unwanted child, or the child who is a misfit in the family or community for lack of companions of his own age, all stand chances of failing to learn the value of human companionship. They learn to withdraw, and so become seclusive. Combinations of social factors may conspire to bring about the same result, in spite of the fact that the child may have started with hereditary tendencies for sociability rather than shyness. Thus, the same trait is the outcome of different causal conditions in different individuals.

Different Traits from the Same Causes. Another difficulty in unraveling the causes of behavior traits is the fact that the same condition often has different consequences in different persons. Treat two children exactly alike, if that were possible, and they will come through with differing personalities. In the face of the same treatment one child reacts positively and another negatively, depending upon what traits they have before the treatment is applied. Punishment of the same kind and severity brings one child into line; he admires the one who inflicts the punishment and adopts for himself the code of the punisher. It causes rebellion or hatred in another, with a growing negative attitude toward all authority and a rejection of the codes of those in authority. There is an old saying that "the same fire that hardens eggs melts butter." This statement surely applies here.

From this discussion it should be clear that we cannot expect to find specific causes that always lead to specific changes in personality. All we can hope to do is to try to see which factors are frequently associated with which differences in personality.

Physique and Personality. When personality is defined so broadly as to include physical differences as well as behavior traits,

the matter of physique is naturally important. But our interest in psychology is primarily in the traits of behavior, so we will examine here only those physical differences that tend to go with certain behavior traits and try to see whether or not there is any causal connection between them.

Some Pseudoscientific Methods. Always wanting quick and easy methods of sizing up the other fellow, people have been ready to seize upon any scheme that promises results. Quacks and charlatans have always been ready with such schemes to meet the demand. Thus we have seen one method after another proposed for reading character and personality from the individual's physical make-up. Phrenology attempted to read characteristics by observing the bumps and depressions on the skull. Physiognomy was an attempt to read personality traits from the shape of the head and face, nose and jaw, hand and fingers, and coloring of hair and skin. All these methods can be dismissed together as being worthless for the practical purpose of evaluating behavior traits in people.

Constitutional Variables. Scientists have paid some serious attention, however, to the factor of general bodily build. It is known that the same glands that produce differences in behavior traits also produce differences in bodily build. Three constitutional variables have been pointed out in recent years by Sheldon. These have to do with general body shape and structure.

With extreme *endomorphy* the individual is definitely roundish, has delicate bones, smooth skin, and sparce hair. There is over-development of the gastro-intestinal tract at the expense of bones and muscles. With extreme *mesomorphy* the individual tends to have large bones and well developed muscles. His general shape tends toward rectangular form and bulging contour in muscular regions. With extreme *ectomorphy* the individual tends toward linearity. He is straight and slender, with relatively greater development of hair, skin, and brain.

Very few people are at these extremes. There are all degrees and combinations of the three components, with the limitation that no one can be more than moderately developed in all three directions. Fig. 22.4 shows how the three extremes can be placed

at the corners of a triangle. A perfectly balanced person, physically, would be at the center of the triangle.

Sheldon believes that there are definite constellations of temperamental qualities tied up with the three physical variables. It

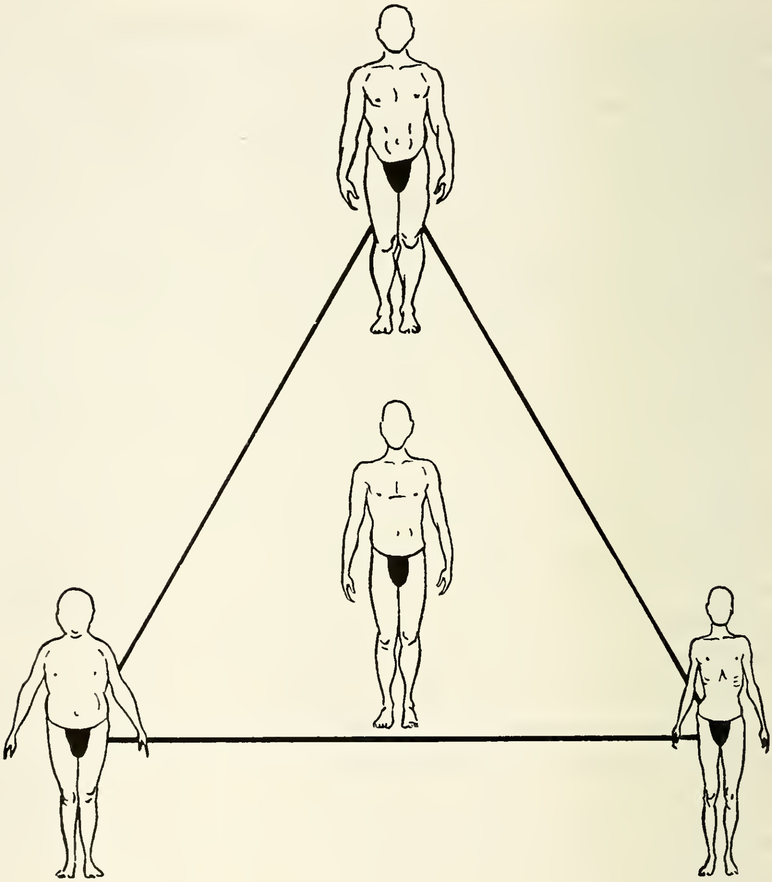

FIGURE 22-4. Triangle illustrating W. H. Sheldon's somatotypes. Each person can be placed somewhere in the triangle.

is probable, however, that the correlations are quite low; not sufficient to make the predictions of behavior from *somatotype* ratings of practical use. The value of Sheldon's somatotype evaluations, then, is chiefly in the description of physical constitution itself in a systematic way.

The Endocrine Glands. For many people the endocrine glands hold the key to personality. This cryptic statement can be interpreted in two ways, both true. On the one hand, the "people" are scientists who believe that we will find the basis of temperamental differences, in general, in the endocrine glands. On the other hand, the "people" are certain individuals who are known to be what they are, different from others, whether effective or ineffective, as a result of their peculiar glandular make-up.

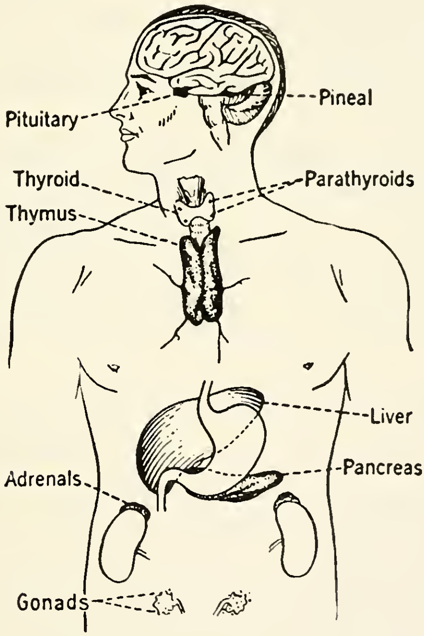

FIGURE 22.5. Diagram showing the endocrine glands. (From J. F. Dashiell, *Fundamentals of General Psychology*, Houghton Mifflin Company.)

The endocrine glands are ductless and pour their secretions directly into the blood stream, which carries them throughout the body. Fig. 22.5 shows the location and general shape of each of the important glands of internal secretion.

(1) *The Thyroid Gland.* The thyroid gland secretes the hormone known as thyroxin. The general purpose of this hormone is to regulate bodily metabolism, that is, the use of food materials in growth and general activity. When the thyroid is underactive,

we speak of a hypothyroid condition. Various degrees of hypothyroidism may occur. The result is usually a mental dullness, with slowness of thinking, memory, and movement, low initiative, indecision, depression, feelings of fatigue with little zest for activity of any kind, and with occasional outbursts of anger when the sluggish person fails to keep up with his faster-moving environment. There is a poor appetite, an inclination to sleep, and a gain in weight.

With an overactive thyroid, known as hyperthyroidism, there is an overactive individual. He rarely stops to rest, sleeps little, has a good appetite, high blood pressure, and he loses weight. In extreme hyperthyroidism he becomes nervous, jittery, and worried.

The hypothyroid condition can now be relieved by taking doses of thyroid extract under the direction of a physician, although this will not necessarily remove all symptoms. It is well to remember that some traits listed for the hypothyroid individual may have other causes than deficient thyroid secretion. The hyperthyroid condition is relieved only by a change in living conditions.

(2) *The Parathyroid Gland.* The chief business of the parathyroid gland is the regulation of calcium metabolism. The excitability of the nervous system is very directly dependent upon the amount of calcium in the blood. When there is a deficiency of calcium, marked changes in behavior are likely to occur. The hypoactive parathyroid leads to an irritable, quick-reacting person, distractible and nervous, with twitchings, fidgeting, and tenseness, sensitiveness to criticism and opposition, and negativism. The hyperactive parathyroids have less dramatic effect, but they are opposite in kind—a general lassitude, loss of muscular tone, and lack of interest.

(3) *The Pituitary Gland.* The pituitary gland has three parts, of which the anterior and the posterior lobes are most often mentioned. Because of its location, its secretions have very prompt access to the brain and undoubtedly affect it directly in many ways. Only one or two definite chemical secretions have been isolated as coming from the pituitary gland, but there are prob-

ably a large number of different hormones produced there. With such a number, each with its own contributions to make to human welfare, it is difficult to say as yet what behavior traits are determined by the pituitary gland. In a general way, the effects of the anterior and posterior parts are known.

The anterior part regulates the growth of bones and muscles and stimulates the growth of sexual functions. A person with an underactive anterior pituitary may become a dwarf, with retarded sexual development. When there is an overactive anterior pituitary gland during childhood, giantism may be anticipated. If it becomes overactive after maturity, the bones of head and face grow out of proportion, producing a distorted countenance and a state known as *acromegaly*. Mentally, the hyperactive anterior pituitary leads to an agggressive, self-controlled individual with poise. The hypoactive gland leads to a sluggish, lazy person who is easily discouraged.

The effects of a disordered posterior pituitary are less well known. In general, this portion acts as a stimulant to the smooth muscles, maintaining their healthy tone. When underactive, obesity is often a result. Mental consequences are submissiveness and a lack of sex interest. When overactive, there are tendencies in the opposite direction.

(4) *The Adrenal Gland.* The adrenal gland, also called *suprarenal,* is situated on top of the kidney, one on either side. It has two parts, the cortex and the medulla, with their respective secretions, *cortin* and *adrenalin* or *epinephrin.* An underactive adrenal cortex is said to lead to such symptoms as general weakness, lack of sex interest, poor judgment, irritability, poor cooperation, poor memory, depression, and insomnia. An overactive condition is said to include virility, composure, alertness, and a feeling of general well-being.

The adrenal medulla is known as the "emergency gland" because of its role in emotional behavior. Some rather characteristic differences in people, that are said to go with this gland and its efficiency, can be cited. An underactive adrenal medulla is likely to show up in the form of dejected moods and a habitual lack of effectiveness in meeting emergencies. A person who should

gain support from the emotional reinforcement may instead give up in the face of extreme demands upon his reactive equipment. With an overactive adrenal medulla, individuals are inclined to be generally more "keyed up," active, dynamic, optimistic, and to possess more initiative, but they are also more inclined to excited moods.

(5) *The Gonads.* The gonads are the sex glands, testes in the male and ovaries in the female. In addition to the production of germ cells, these organs serve as endocrine glands, secreting perhaps three different hormones. During childhood they remain more or less in a latent condition. At puberty, one of their functions is to bring about development of the masculine physical traits in males, and the feminine traits in females. Certain mental characteristics go along with this development, including normal interest in the opposite sex. It should be recognized, however, that no individual is a complete male in every respect, and no one is a complete female in every respect, either physically or mentally. This is partly because it takes more than one hormone to bring about male or female characteristics. Many differences between the sexes in behavior traits can undoubtedly be attributed to glandular disposition. But many differences are to be attributed also to cultural forces that treat developing boys and girls differently, because of their sex membership.

Interaction of the Glands. One gland cannot be overactive or underactive without having effects upon other glands. Some glands inhibit one another, and others stimulate one another. Again, when some glands fail, others become overactive as if to compensate for the failure. This greatly complicates the glandular picture and makes a clear-cut correlation between glandular make-up and behavior traits almost impossible. It is the glandular balance rather than specific conditions of single glands that is significant for behavior.

Influence of Behavior upon Glands. It might be supposed that one's glandular make-up is hereditary, and insofar as glands determine behavior traits, to that extent heredity is to blame for personality. This leaves out of account the effects of diseases and

accidents upon glands. Tumors, injuries, and toxic effects of diseases may leave their mark upon almost any gland, changing its functions decidedly. It also leaves out of account the effects of behavior upon the glands. The relationship between glands and behavior works both ways. They are under the influence of the nervous system, and one's ways of reacting, particularly one's emotional habits, may leave permanent changes in gland functions that in turn modify personality. This phase of glandular disposition deserves much closer study than it has received in the past.

Glands and Behavior Problems. Disturbances of glandular function very frequently enter into cases of misbehavior. Among 250 prison inmates it was found that lack of glandular balance was two or three times as prevalent as among normal individuals.[4] Among 1000 problem children 20 per cent had glandular disturbances, about half of these showing apparent connection between glands and misbehavior. The gland most frequently at fault was the pituitary, and the thyroid was next.[5] Treatment with glandular extracts in many cases has resulted in remarkable improvements in behavior, although it has not by any means solved all problems, and must as yet be administered only after careful study and with continued care.

Changes with Age. How consistent is an individual in his behavior traits as he grows up? At what ages do different traits first appear? We have only begun to answer these questions. Differences in such traits as initiative, friendliness, dominance, and determination make their appearance in children aged two to three years. Genuine rivalry does not appear until ages four or five.[6]

Certain other traits appear in the one-year-old child and seem to persist rather consistently for some years following. Five infants were rated carefully on 15 traits at the age of one year, based upon observations in standard test situations, and in motion pictures made at their homes.[7] They were rated again four years later by the same trained nurse under the same conditions, who again placed the five in rank order for every one of the 15 traits. As a result, among the 75 rank positions made at age 1 and age 5, 48 agreed exactly. These were for such traits as motor adjustment,

self-dependence, affection for family, sense of humor, emotional adjustment, and reaction to restriction. There were decided changes in such traits as reaction to success, social responsiveness, adaptability, and readiness to smile or cry.

Such few studies as we have cited only show the possibilities of predicting certain traits in cradle days and of showing which other ones are more subject to training. Other studies show that traits exhibited in children before adolescence are usually retained after adolescence and often into adult life. Certainly, there is a strong thread of consistency running through the life of an individual.

The Family Environment. The average child lives on such intimate terms for so many years with members of his immediate family that it is little wonder that this small social group should exert very powerful influences upon his behavior traits. The kind of father and the kind of mother he has should make much difference. They reward and punish him in hundreds of ways, day in and day out. They set the pattern for him to emulate or to avoid. They select as best they can what influences external to the home shall bear upon him; the kind of playmates he shall have, the kind of school to which he shall go, and other social agencies that may come in contact with him. The number of siblings he has, his position among them, and the nature of their personalities, all contribute to his development.

Fathers and Mothers. It is very difficult to show that the same condition has consistent effects on different children, as was pointed out before. For example, there are various kinds of fathers—domineering, submissive, incompetent, immoral, over-religious, companionable, and famous fathers. Different children react differently to the same kind of father. And yet, certain general consequences may be expected in response to each kind of father. On the whole, companionable fathers contribute to their children a greater emotional stability and self-assurance. Domineering fathers are likely to create submissive children, with now and then a rebellious son. But unfortunately, extensive data on this and on other types of fathers we have mentioned are lacking as yet.

Mothers may differ from the average in being domineering, oversubmissive, invalid, over-motherly, or nagging. Certain traits should develop more readily under the influence of one kind of mother than another, other things being equal. Nagging mothers, for example, are likely to send children in the direction of shyness, submissiveness, and emotional instability. The same is true of overmotherly mothers who spoil their children. But again, there are different varieties of "spoiled" children, depending upon how the child takes to the over-mothering and what the other circumstances in the family are.

Unusual Family Situations. Certain unusual family situations may leave their marks upon some children. Incompatible, quarreling parents, who should be divorced but are not; divorced parents who fight over the custody of the child, both produce situations in which the child often develops strong feelings of insecurity and inferiority from which he may never fully recover. The fact that a child's family is different in any questionable way from other families is likely to place him in need of compensation for hurt feelings. Probably of less importance, as a rule, is the fact that a child is an orphan or part orphan, an adopted child, or a stepchild. Much depends upon how seriously he feels his unusual position, if he does at all.

Positions in the Family. Every child, if he has any brothers or sisters at all, occupies a unique position in his family. He is the eldest, the second, or the middle child, or he is the youngest, or in some other special position. Circumstances may make him the favorite or worshiped child, or they may make him an unwanted intruder. He may be one boy among several girls, or the only girl among a number of boys. As the youngest he may be either unduly petted or teased, or both. Do these factors have any consistent effects, other things being equal?

Several studies have seemed to reveal certain handicaps that often beset the path of the eldest child. It is true that the parents are younger and less experienced in child rearing in his case than they will be for any of the other siblings. At kindergarten age it was found that the eldest child is inclined to be lacking in self-confidence, aggressiveness, and leadership, and is slightly more

suggestible and seclusive than other children. The eldest child is also found somewhat more prone to behavior problems.[8] The favorite child is likely to face rude awakenings and serious conflicts later, unless circumstances continue to prevent them. The unwanted child is likely to develop feelings of insecurity and inferiority, and a resentment that transfers to all who later stand in the relation of substitute parents to him. The only boy among girls, contrary to common opinion, is not made more effeminate, and the only girl among boys is not masculinized by them.[9]

The Only Child. Because of his unique family structure, the only child has long been singled out for psychological interest. The common idea is that, because he is an only child, he will therefore be pampered and spoiled. Compensating for this danger, however, are several more favorable circumstances. The only child usually has parents above average in intelligence and in social and economic status. His own physical and mental endowment are likely to be good, and the cultural level of his home is favorable. During grade-school years, studies have shown the only child to be superior in most respects to other children, including abilities, scholarship, habits of health and character, and not to be inferior in social and emotional adjustments.[10] Studies of college students by means of personality questionnaires, however, show that only children are slightly different from others in being more emotional and nervous.[11]

Constellations of Factors. Factors having to do with family life, as well as other factors, never act singly. Combinations of factors often have decided influences upon a child, where certain elements of those combinations taken alone would be ineffective. An exceptionally dominant mother plus a weak father is a different situation than two dominant parents, although in both cases there is a dominant mother as the constant element. Either of these two combinations may have different effects in a poverty-stricken home than in one of wealth or of moderate means. It would probably pay us to give more attention to all unusual family contellations and their effects upon developing personalities. The results in terms of altered traits may be more striking than when we examine one causal factor at a time.

This kind of study of family situations is often made in dealing with particular individuals, usually those involved in some behavior problem. While such a single item as being a second child in the family has no significance in the long run, for one particular child it may be the key to his troubles. For example, when the second child is some years younger than the eldest, and of the same sex, his over-dependence and submissiveness may derive very directly from that fact alone. As another example, when the older of two children of the same sex is less attractive, less intelligent and clever, there results an unbearable situation for the older of the two, especially when social custom expects him to take precedence over the younger one. Many other single instances of this kind could be mentioned.

Can Personalities Be Changed? Since environmental factors are known to have their effects in making personalities different, can we control the environment of an individual so as to produce significant changes? This has proved to be the case in many instances. Many a problem child is improved for the better simply by removing him from one home and placing him in another. Of 100 children so treated, 72 showed definite improvement and only 19 did not improve.[12] Experiments have shown that, with special training, some traits can be definitely cultivated. Among a group of submissive children three to four years old, half were singled out for training designed to make them more ascendant, and the other half, a control group, was let alone. The trained group showed a marked change toward ascendance, whereas the control group, by contrast, lost in that respect.[13]

In a study of students, 25 were selected out of 400 to become subjects for special training. They were at both extremes of the ascendance-submission scale. After about six months of interviews, advice, reading about the subject, correction of handicaps, and with the aid of associates, the submissives improved considerably, but the ascendant ones remained the same.[14] Factors found in the lives of the submissives were: lack of opportunity for initiative at home, undue parental restraint, and other circumstances causing feelings of inferiority. Some probable causal factors for ascendance were: responsibility assumed early in life, positive par-

ental training in self-confidence and initiative, many social contacts in childhood and adolescence, success in athletics, unrestrained freedom, and compensation for some recognized defect.

From these few examples it can be seen that people can be changed in some traits, even after reaching the age of college students. This would not necessarily hold true of some temperamental trait that depends more upon a person's glandular make-up. But it holds true wherever the trait is more the result of habit formation. Then it is a matter of relearning or re-education. The success of the relearning will depend upon the intensity of the effort in practice and the amount of time given to it. It also assumes that the person who is being retrained really wants to be different, having no strong motives for remaining as he is.

Economic Environment. No child, unless he is a bedridden invalid, can remain exempt from the community life around him. He cannot help being colored to some extent by this larger milieu outside his home. We are often told that communities where there is poverty, and all the things that usually go with it, are decidedly unfavorable for the development of desirable personality traits. We are often told just as emphatically that poverty and want bring out the best efforts of a child, and a strong, self-reliant personality results. Men who have risen from rags to riches are cited to prove this assertion. What are the actual facts?

Scientific studies show that neither extreme statement is quite correct. One study of 112 children from 60 families in two communities, differing in their social and economic advantages, showed that the physical environment, as such, was not very important.[15] As judged by the percentage of emotional adjustment, the two were equally conducive to stable development. The attitudes of the parents toward their environment, however, were very influential. It is when families grow discontented with their lot, resulting in tensions among members of the family and inferiority complexes in the individuals, that emotional maladjustments arise.

Another study showed that students who grew up in homes with poor economic advantages were not helped by such hardships. They were more prone than normal students to inferiority feelings, nervousness, emotionality, shyness, and lack of social

initiative.[16] On the whole, then, economically poor homes and communities do not improve personalities. The rare self-made man, who begins life under adverse conditions, is making good in spite of discouraging handicaps and because of an innately strong personality, or because of a compensatory drive against strong feelings of inferiority, or both.

Social Roles. Outside the home the child enters a more or less organized social group or groups, where every individual must find a place. What place he will occupy, whether dominant or submissive, in the limelight or in the shadow, will depend to some extent upon what qualities he already has. It also depends upon what the group wants of him and where he arouses the least tension and the greatest satisfaction. He soon takes on some role which has much to do with the direction of his further development. He may become the bully, the dunce, the snob, the tagalong, the ugly duckling, the daredevil, the bookworm, or he may become the catspaw or just the goat. Many other childhood roles could be mentioned. Having been assigned to his role, he is encouraged to act the part and he either gains satisfaction from doing so or finds the minimum tension in that way. Habitual traits are thus formed. We do what is expected of us and repeat what gives us social approval. Occasionally, a child forces himself out of one role and into another, but he does so against social pressure.

Later years bring the individual into other social roles, some self-chosen to some extent, but many of them still forced upon him. We find the athletic hero encouraged to continue developing along the lines expected of him. The campus beauty, the Don Juan, the intellectual, the radical, the activities man, and the politician, all cultivate traits in line with their original slants that have gained personal satisfaction and social approval. Professional interests crystallize, bringing to a focus many previously unorganized habits, interests, and attitudes, until, in middle life, we can often detect that bedside manner, that schoolmarm look, or that ministerial benignity.

With the demonstration that social forces can change the course of an individual's personality development, sometimes dra-

matically, it is no wonder that some are ready to claim that a personality is entirely a product of its social environment. To reach this conclusion, however, would be to lose sight of the fact that infants have definite personalities before social factors get in their work and that many of these qualities observed in the infant cling, stubbornly, sometimes, throughout a lifetime. The individual is a product of his heredity and his environment.

Summary

From a scientific standpoint, personality includes all the traits that make one person differ from another, and that make each individual a unique specimen. The psychologist's interest is primarily in the traits of behavior. He attempts to measure all traits of behavior, just as in mental testing he attempts to measure abilities. Rating scales, questionnaires, and tests are the customary tools of measurement of personality traits.

Characteristic ways of behaving in any individual, develop in a number of ways and from a number of sources. Some qualities are given bents to develop in certain directions because of hereditary factors. Other qualities arise because habits of reacting become generalized, codes of conduct are formed, much as a concept forms, and the individual is thus given bents to develop in certain directions. Some traits are highly generalized and others are more specialized. Without generalized qualities of behavior, without some consistency, we could not speak of behavior traits at all.

The popular tendency, in classifying people, is to place them into discrete categories called personality types. The types usually go in pairs of opposites, like extroverts and introverts. It is true that almost every trait has an opposite, but the psychologist finds that people possess these two tendencies to varying degrees. We more properly speak of dimensions of personality rather than types of personality. On any dimension, as on the scale of any ability, a population probably tends to be normally distributed, with very few individuals at either extreme and the bulk of humanity near the center of the scale.

There are thousands of trait names, and thousands of dimensions of personality, if we allow every pair of opposites to become a

dimension. Statistical analysis shows that there is so much overlapping in these dimensions that we can get along with a rather small number. Factor analysis shows what the primary traits or dimensions are, and that a limited number of them will be sufficient to give a significant description of personalities.

The study of the causes of personality traits is a most intricate and baffling one. The hope of pinning a single, isolated cause upon every trait is doomed to disappointment. For centuries there have been some, many, in fact, who have placed their hopes in physique as an indicator of personality, if not its cause. Scientific examination of all such claims has left a very thin base on which this approach stands. There is much more hope of finding a correlation between body chemistry and personality, because body chemistry depends very much upon the glands of internal secretion, and these glands are known to influence behavior in various ways. Of the glands, the thyroid, parathyroid, pituitary, adrenals, and the gonads seem most capable of qualifying behavior.

Rather important for personality development are social conditions in the family and in the neighborhood immediately surrounding the child. The way in which his emotional reactions are conditioned and generalized and the way in which he adjusts to other people, particularly his parents and other members of his family, are of great importance, it is now believed. Fortunately, studies show that patient and systematic training are sufficient to change some individuals in some respects. More important, however, would be the plan of having every parent and teacher versed in the techniques of guidance of personalities in the ways that those personalities should grow.

Questions

1. Give reasons for and against defining personality as "the effect a person has on others."
2. Collect a number of definitions of "personality" from various sources. Which ones are purely popular and which ones would do as scientific definitions? Explain.
3. Set up a linear rating scale similar to the one for persistence. for some other dimension of personality in which you are interested.

Have several judges rate the same two acquaintances on the scale. Secure self-ratings of the two. Discuss the results.

4. Plan a new performance test of some trait in which you are interested, and give a complete description of the procedure. If possible, apply it to one or more subjects and report results.

5. Prepare a list of ten questions that should probe some particular trait or dimension, making up a brief questionnaire. Apply it to two or more subjects whose standing on this dimension you already know fairly well. Report results.

6. Summarize the conditions that make for consistency of behavior traits in individuals, telling what role each one plays.

7. How do you account for the origin of the belief in discrete types of personality?

8. What logical reasons are there for expecting some relationship between physical traits and behavior traits? Which of these relationships do you know to be borne out by experimental facts? Cite the facts.

9. Are the relations of behavior traits and body chemistry probably due to heredity or to environmental factors, or both? Explain.

10. How much truth is there in the statement that "criminals are born and not made?" How can heredity affect criminal behavior?

11. Select some acquaintance you know very well who has outstanding traits. Try to account for those traits from what you know of his heredity and his past environment, in home, in school, and in his community life.

12. What treatment would you recommend for a student who is lacking in aggressiveness to the extent that he is handicapped?

13. Write for your own consumption a short autobiography entitled, "Why I am what I am."

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